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Walking and cycling crash risk in Australia: six-state analysis

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Abstract
People walking and cycling are disproportionately represented in fatal and serious injury crashes, yet cross-jurisdictional data on their crash patterns remains fragmented. Police-reported crash records from six Australian states (NSW, VIC, QLD, WA, SA, TAS) were analysed over a common two-year window, drawing on the most recent available data (110,498 crashes). VRU crashes were identified using standardised mode fields. Severity, population-adjusted rates and LGA-level patterns were computed. 11.4% of crashes (12,649) involved a pedestrian or cyclist. VRU share in fatal crashes (15.5%) was 1.7 times the minor injury share (9.2%). State VRU share ranged from 8.0% (WA) to 17.1% (VIC); per-capita rates told a different story, with TAS and VIC highest. Urban LGAs dominate the top of the distribution. Cross-jurisdictional variation in VRU crash patterns is substantial and reflects differences in modal mix, urban form and data collection practices. Inconsistent data standards across jurisdictions limit national analysis.

Introduction
People walking and cycling (often grouped as vulnerable road users, or VRUs) are among the most at-risk groups in the road network (World Health Organization, 2023). This paper uses person-first language throughout; police crash records use mode-based classifications (pedestrian, cyclist) which are referenced as recorded where necessary. The National Road Safety Strategy 2021–30 identifies reducing death and serious injury to people walking and cycling as a priority, and targets a 50% reduction in fatalities and 30% reduction in serious injuries by 2030 (Australian Government, 2021; Australian Government, 2023). Yet with 1,314 road deaths in the 12 months to December 2025 (Bureau of Infrastructure and Transport Research Economics [BITRE], 2025), progress toward these targets remains insufficient.

Despite the policy priority, practitioners and councils frequently lack access to a consolidated, cross-jurisdictional picture of how crashes involving people walking and cycling (referred to here as vulnerable road user or VRU crashes, consistent with source data terminology) are distributed: by state, by severity, and by local area. State crash datasets are published independently, use inconsistent field definitions, and are updated on different schedules. This makes direct comparison difficult and limits the ability of councils and agencies to benchmark their local patterns against peers. This paper addresses that gap. Using police-reported crash records from six Australian states over a common two-year window, it presents a reproducible national analysis of crash patterns involving people walking and cycling, including state-level variation, severity over-representation, LGA clustering, and the data quality constraints that shape what this kind of analysis can and cannot show.

Conference theme
This paper directly addresses the ARSC2026 theme “From Evidence to Action” by producing a national VRU crash baseline that practitioners and councils can act on immediately: identifying where risk is concentrated, which severity patterns warrant priority investment, and where data gaps limit local decision-making. The methodology is openly documented and replicable, enabling any practitioner to apply the same approach to their own jurisdiction or local area using publicly available data.

Method
Police-reported crash records were obtained from six Australian states: NSW, VIC, QLD, WA, SA and TAS. ACT was excluded due to unavailable mode-of-transport data. NT was excluded as data was not available for this analysis.
To enable fair cross-state comparison, a common analysis window of 1 January 2022 to 31 December 2023 was applied to all states. All states have published crash data covering this period. Each state’s data uses slightly different field names and mode classifications; these were mapped to a common schema prior to analysis. Analysis was conducted in early 2025.

A crash was classified as involving a person walking or cycling if the mode_involved field contained any of: pedestrian, bike, or bicycle (TAS uses ‘bicycle’ rather than ‘bike’).

This analysis focuses on active transport modes. Motorcycles are excluded on the basis that their risk profile, infrastructure needs and policy levers differ substantially from those of people walking and riding.
Severity was normalised to three categories: fatal, serious injury and minor injury. Fatal is defined as a crash resulting in at least one death. Serious injury is defined as a crash resulting in hospitalisation; the specific threshold varies by

state - some jurisdictions require overnight admission while others include any hospital attendance. Minor injury captures treated-and-released or reported injuries below the serious injury threshold. These definitional differences limit direct cross-state comparison of severity distributions and are noted where relevant in the findings.

Reporting thresholds, the minimum criteria for a crash to be recorded in the police-reported dataset, also vary by state and typically require either property damage above a set value or injury of any kind. This particularly affects minor cyclist crashes, which are under-represented in all six state datasets.

LGA analysis excluded TAS, which does not include LGA fields in its published crash data.

Population-adjusted rates were calculated using ABS June 2024 Estimated Resident Population figures, annualised across the analysis window. All analysis was conducted programmatically in Python using open-source libraries, with outputs verified against published state agency summaries where available.

Data caveats: Police-reported data under-represents minor incidents, particularly single-cyclist falls. Reporting thresholds differ between states, limiting direct comparison. Per-capita rates use total resident population, not walking or cycling exposure, and should be interpreted accordingly.

Findings

National overview

Across 110,498 police-reported crashes in six states during 2022–2023, 12,649 (11.4%) involved a person walking or cycling. This equates to approximately one in every nine crashes involving a person walking or cycling.

Severity over-representation

VRUs are disproportionately represented in the most severe crash categories. Nationally, 15.5% of fatal crashes involved a person walking or cycling, compared with 14.6% of serious injury crashes and 9.2% of minor injury crashes, giving a ratio of approximately 1.7:1 between fatal and minor (Table 1).

Table 1. VRU crash share by severity, six-state aggregate (2022–2023)

Severity	Total crashes (6 states)	VRU crashes	VRU share (%)	Notes
Fatal	1,997	309	15.5%	VIC 20.4%, SA 21.5%, NSW 17.8%
Serious injury	42,902	6,279	14.6%	Consistently elevated across all states
Minor injury	65,598	6,061	9.2%	Likely under-reported for cyclists

Note: Minor injury counts are likely under-reported, particularly for cyclists.

State-level variation

VRU crash share varies substantially across jurisdictions, from 8.0% in WA to 17.1% in VIC (Table 2). However, raw share and population-adjusted rates tell different stories. TAS records the highest per-capita VRU crash rate (38.1 per 100,000 residents per year), closely followed by VIC (37.7). NSW and WA are lowest by both measures.
This variation reflects a mix of urban density, cycling infrastructure, modal share and reporting practices rather than safety performance alone. It highlights the importance of using consistent methods and appropriate denominators when comparing states.

Table 2. VRU crash patterns by state, common 2022–2023 window

State	Total crashes	VRU crashes	VRU share (%)	VRU per 100K/yr	Ped per 100K/yr	Cyc per 100K/yr
VIC	23,047	3,948	17.1%	37.7	18.8	19.2
SA	7,278	1,180	16.2%	31.5	12.6	19.0
TAS	1,874	236	12.6%	38.1	23.9	14.7
QLD	26,631	2,820	10.6%	26.4	13.0	13.5
NSW	36,966	3,284	8.9%	20.2	11.9	8.6
WA	14,702	1,181	8.0%	20.0	9.4	10.8

Source: State road safety agencies (police-reported crash data). Analysis by authors.

LGA-level clustering

Among LGAs with at least 200 crashes in the analysis period, VRU share is highest in dense urban centres. The top five LGAs by VRU share were Yarra VIC (47.4%), Adelaide SA (44.0%), Port Phillip VIC (42.4%), Melbourne VIC

(39.4%) and Bayside VIC (38.8%). These LGAs reflect areas with higher walking and cycling activity and mixed land use, rather than simply greater risk per trip.

At the other end of the distribution, outer suburban and regional LGAs typically record VRU shares below 6%, reflecting lower active travel mode share rather than better safety outcomes for those who do walk or cycle.

Benefits to road safety

This analysis demonstrates what is achievable when crash data is processed consistently across jurisdictions. The findings give practitioners, councils and agencies a reproducible national VRU baseline, evidence of where crashes are concentrated by state, severity and local area, and a methodology applicable to any jurisdiction using publicly available data.

Implications for policy and practice

First, VRU severity over-representation is consistent across all six states. People walking and cycling have far less protection than vehicle occupants. This reinforces the case for Safe System infrastructure: reduced operating speeds, separation and crossing improvements as priority investments regardless of jurisdiction (Mooren & Shuey, 2024). Second, cross-jurisdictional variation in VRU crash share partly reflects how states collect and publish data, not only actual safety differences. ACT mode data is unavailable; WA data does not extend beyond December 2023; reporting thresholds and field definitions vary. Risk assessment frameworks for local government should account for these limitations when drawing on cross-jurisdictional crash data (Harris, Mansoor & Colbran, 2024). State agencies should treat data release consistency as a road safety intervention in its own right: common field standards, regular annual publication and machine-readable formats enable faster identification of harm and more defensible local investment decisions.

Third, under-reporting of minor crashes, particularly single-cyclist incidents, means the true extent of VRU harm is greater than police-reported data shows. The 1.7:1 ratio between fatal and minor VRU crash share is best understood as a floor, not a ceiling: as minor incidents are systematically under-captured, the apparent severity skew is amplified. For practitioners using crash records to prioritise sites or allocate funding, this has a direct consequence: locations with high cycling activity but lower serious crash counts may be under-prioritised despite carrying substantial latent risk. Supplementary data sources such as hospital admissions, emergency department records and insurance claims are necessary to form a complete picture of VRU harm, and investment decisions should be interpreted against that limitation.

Conclusions

Across six Australian states in 2022–2023, 11.4% of police-reported crashes involved a person walking or cycling. People walking and cycling were 1.7 times more likely to appear in a fatal crash than a minor one. State-level crash share ranged from 8.0% to 17.1%, with per-capita rates telling a different story again. Urban LGAs dominate the high end of the distribution.

These findings are reproducible and will be updated as new state data becomes available. The methodology is openly documented and replicable at the local level using any state dataset.

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Monitoring pedestrian safety performance: critical SPIs and KPIs

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Abstract
Pedestrian safety performance cannot be managed effectively using final outcomes alone. Under Austroads Keeping People Safe When Walking project, we developed a practical pedestrian safety KPI/SPI suite for Australia and New Zealand to support monitoring, diagnosis and continuous improvement. We defined core pedestrian safety concepts – i.e. final outcomes, intermediate outcomes (SPIs) and delivery measures (KPIs) –, then synthesised leading international performance frameworks and applied subject matter expertise to draft long lists of candidate KPIs/SPIs. These were iteratively refined into (i) Pedestrian Safety Management KPIs covering governance and system capability, (ii) Safe System delivery KPIs tracking implementation scale and quality, and (iii) a pedestrian SPIs framework covering Safe System components and walking demand. The SPIs framework identifies 17 "must-have" pedestrian SPIs spanning impairment, speeds, crossing provision, footpath/separation coverage, perceived safety and walking uptake. Jurisdictions are encouraged to adopt and publish these indicators to strengthen accountability and accelerate progress toward 2030/2050 targets.

Background
Reducing pedestrian fatal and serious injury trauma requires more than counting crashes, or fatal and serious injury counts: jurisdictions also need Key Performance Indicators (KPIs) that track delivery performance (e.g., program reach, treatment rollout, monitoring coverage) and Safety Performance Indicators (SPIs) that track the system conditions that cause risk and injury severity (e.g., speeds, impairment, crossing safety and separation). This is we can prevent pedestrian trauma through proactively building ped safety management capability, and proactively de-risking the system through echo of the Safe System components. This work was completed under Austroads Project SAG6371, Keeping People Safe When Walking—a multi-year program (2023–2026) supporting Australia and New Zealand to significantly reduce pedestrian trauma, aligned with Safe System ambitions for 2030 and toward zero by 2050. Within Stream 2, the Systemic Predictive Tools for Pedestrian Safety work package focused on developing methods and prototyping a tool to estimate pedestrian crash risk and exposure, and to calculate pedestrian SPIs suitable for routine reporting and monitoring.

Conference theme
This work directly aligns with the Australasian Road Safety Conference 2026 theme, "From Evidence to Action: Shaping a Brighter Future", by translating the evidence base on pedestrian safety into *operational, reportable KPIs and SPIs* that can be embedded in jurisdictional road safety management systems.

Method
The work commenced by establishing a consistent conceptual and practical foundation for pedestrian safety performance measurement across Australia and New Zealand. We then developed specific and internally consistent definitions for pedestrian final outcomes, SPIs and KPIs, drawing on established road safety management literature and practical monitoring guidance. The intent was to make each indicator class "fit for purpose":

- final outcomes as observed health impacts
- SPIs as causal operational conditions that shape crash risk and injury severity
- KPIs as measures of the scale, quality and timeliness of pedestrian-safety actions and program delivery.

These definitions were tested using illustrative case examples (e.g., speed management and vehicle safety features for pedestrians) to demonstrate how KPIs, SPIs and final outcomes interlock in practice and to confirm that indicators could be positioned consistently across diverse intervention types. A targeted scan of conceptual, theoretical and practice-oriented sources was undertaken to identify the strongest existing approaches to pedestrian-related SPIs and KPIs, including Safe System-aligned frameworks and performance-monitoring methodologies used internationally.

Rather than adopting any single framework wholesale, we synthesised common, high-value elements (e.g., causal linkage to injury prevention mechanisms, system-level applicability, and operational measurability) and complemented them with subject matter expertise to ensure relevance to Australasian governance arrangements, speed environments,

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and data realities. This synthesis step informed the structure of the KPI and SPI frameworks and guided the selection criteria used to screen and refine candidate indicators.

For pedestrian KPIs, we developed a framework that separated:

- **pedestrian safety management KPIs** (capturing delivery performance such as planning, investment, coverage, implementation quality and monitoring capability) from
- **Safe System delivery KPIs** (capturing tangible rollout of Safe System actions relevant to pedestrians).

Candidate KPIs were assembled into an initial long list, then iteratively refined into a short list and final consolidated set by applying consistent selection criteria—clarity of definition, interpretability, feasibility of routine reporting, and usefulness for governance and accountability. Particular attention was given to ensuring KPIs could be aggregated and trended over time, while still supporting disaggregation where it matters for program management.

For pedestrian SPIs, we applied a structured, stepwise process to move from a comprehensive long list to a refined short list and then a consolidated list that was organised using Safe System components (Safe Road User, Safe Road, Safe Speed, Safe Vehicle) plus a dedicated Walking Demand component. SPIs were screened for strong causal relevance to crash risk or injury severity, intervention neutrality (where appropriate), sensitivity to change, and practical measurability at scale. The final framework explicitly classified SPIs as **Must-Have** versus **Could-Have** to support staged adoption: the Must-Have set was treated as a core minimum needed for Safe System–aligned pedestrian safety management, while Could-Have indicators provided an expansion pathway for jurisdictions that had the data maturity and resources to go further.

Results

Pedestrian safety management KPIs: governance and system capability

The project produced a practical, reportable set of **Pedestrian Safety Management KPIs** designed to strengthen governance, accountability and system capability for pedestrian safety delivery. The KPIs cover core institutional functions that determine whether pedestrian safety is prioritised, coordinated and sustained—namely leadership and target-setting, cross-agency coordination, enabling legislation and policy, forward funding and resourcing, data publication timeliness, research and capacity-building, advocacy and behaviour-change reach, standards and guidance uptake, and equity and inclusion. Each KPI was specified with a clear definition, nominated “responsible” agency, and an assessment frequency to support routine performance reporting and comparability over time.

Safe System delivery KPIs: what is being implemented and at what scale

To complement the management KPIs, the project developed a **Safe System Component KPI** suite that tracks the scale and quality of pedestrian-relevant interventions and system changes across the Safe System. The KPI set spans **Safe Roads** (e.g., raised and priority crossings, safety performance of pedestrian environments, protected pedestrian phases at high-risk signalised intersections, pedestrian Safe System assessments for arterial projects, and school-area safety provisions), **Safe Speeds** (e.g., coverage of ≤30 km/h in pedestrian-priority contexts and enforcement effort), **Safe Vehicles** (e.g., penetration of pedestrian-AEB/ISA and safer fleets), **Safe Road Users** (e.g., delivery of education and high-visibility enforcement operations), and **Post-Crash Care** (e.g., emergency response time and trauma capability), with an “Other” category capturing system-level mode shift and traffic reduction in pedestrian-activity areas. Importantly, these KPIs were defined with minimum data specifications and routine reporting frequencies, providing a structured pathway for agencies to monitor implementation progress and program reach alongside changes in intermediate outcomes and final trauma.

Pedestrian SPIs: intermediate outcomes, including a 17-SPI ‘must-have’ core

The primary technical output was a Pedestrian SPIs Framework that operationalises pedestrian safety performance as intermediate outcomes—system-level conditions that causally influence crash risk and injury severity—and that can be monitored ahead of changes in fatalities and serious injuries. The framework adopted Safe System components (Safe Road User, Safe Road, Safe Speed, Safe Vehicle) and added walking demand to ensure that exposure and uptake of walking are interpreted alongside risk-reduction measures.

The final SPI set includes 17 Must-Have SPIs that the project team considered a core minimum for Safe System–aligned pedestrian safety management: impaired driving (BAC and drugs), public perceived safety and convenience of walking; crossing provision and quality (crossing density and raised crossings); pedestrian network provision and separation (urban and rural footpath coverage, ≥70 km/h separation, central-city pedestrian space); and speed conditions in pedestrian contexts (≤30 km/h coverage in relevant Movement & Place settings, 85th-percentile/mean speeds, and speeding exceedance profiles), plus two Walking Demand SPIs (mode share and trend in volumes at permanent monitoring sites). The framework also identifies Could-Have SPIs—including risk-modelling outputs and vehicle-technology penetration measures—to support staged adoption where jurisdictions have the data maturity and resources to expand beyond the core set.

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Benefits to road safety

This work strengthens pedestrian road safety outcomes by giving jurisdictions a practical, Safe System–aligned measurement set that sits between day-to-day delivery and long-term trauma reduction. The SPI framework enables earlier detection of deteriorating pedestrian safety conditions (e.g., rising operating speeds, low coverage of ≤30 km/h in pedestrian-priority areas, gaps in safe crossing provision, or lack of safe, separated pedestrian facilities in ≥70 km/h environments) and provides a clearer diagnostic basis for targeting countermeasures before changes appear in fatal and serious injury (FSI) outcomes. The KPI suites strengthen the enabling conditions for sustained improvement by tracking whether jurisdictions are (i) setting targets and governing the problem effectively, (ii) delivering interventions at scale and with quality, and (iii) building the data systems needed for transparent reporting. Together, these outputs support more effective prioritisation, faster learning cycles, and more accountable delivery—improving the likelihood that investment translates into measurable reductions in pedestrian trauma.

Implications for policy and/or practice

The outputs have direct implications for how agencies plan, govern, deliver and evaluate pedestrian safety:

- First, jurisdictions can embed the 15 Must-Have pedestrian SPIs into road safety strategies, action plans and performance dashboards as a minimum monitoring baseline. These indicators are intended to support reporting and decision making across multiple levels of the system—including national, state, regional and local government contexts—with application scaled according to capability, data availability and organisational responsibilities.
- Second, the results provide a structured basis for program management: agencies can operationalise Safe System delivery KPIs to track the rollout and quality of pedestrian-safety treatments and the Pedestrian Safety Management KPIs provide an accountability and capability backbone for practice, requiring demonstrable leadership (targets and dashboards), cross-agency coordination, enabling legislation and standards uptake, timely publication of indicator series, and equity impact assessment—so pedestrian safety improvement is not solely opportunistic, but systematic and auditable.

Conclusions

This project delivered a coherent set of pedestrian KPIs and SPIs for Australia and New Zealand. Collectively, the KPI/SPI suite provides jurisdictions with a practical mechanism to move from intention to measurable delivery and to monitor whether system conditions that drive pedestrian risk are improving. Next steps include supporting jurisdictions to pilot reporting for the Must-Have SPIs, harmonising measurement specifications (including Movement & Place disaggregation where feasible), and progressively uplifting data systems so that “Could-Have” indicators—such as modelled risk measures and vehicle technology penetration—can be implemented consistently across the region.

Implementation is expected to occur progressively through pilots, capability building and staged adoption, recognising that different jurisdictions and local governments have different data maturity, resourcing and monitoring needs.

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Seatback recline effects on child restraint performance during frontal crashes

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Abstract
Future autonomous vehicles may allow reclined occupant postures, altering kinematics and injury mechanisms for children in child restraint systems (CRS). This study examined the effect of seatback recline on crash performance of Australian Standards-approved rear-facing, forward-facing and high-back booster seats. Twenty-one frontal sled tests (27g, ΔV=49 km/h) were conducted using a standardised captain's chair with a load-limited, sash-pretensioned seatbelt. A Q1 anthropometric test device (ATD) was secured in rear-facing CRS, and a Q6 ATD in forward-facing CRS and booster at 21°, 36°, and 51° recline. Most ATD sensor metrics reduced with recline in the rear-facing CRS but increased neck extension moments. In forward-facing CRS, harness slip at 36° and 51° resulted in increased head excursion, while elevated metrics occurred at 36° when slip did not occur. No submarining occurred in boosters, although recline increased head, neck and chest responses. Findings indicate the need for CRS design adaptations to accommodate reclined seating.

Introduction
Future highly automated vehicles may allow a wider range of occupant postures, including reclined seating, to support varied in-vehicle activities (Jorlöv et al., 2017). However, reclined postures pose a challenge to the performance of existing child restraint systems (CRS), which were not designed to manage altered occupant kinematics. Research on the use of CRSs with reclined seating is limited and focuses mainly on booster seats alone (Graci et al., 2022; Hauschild et al., 2023). Studies demonstrate variable performance depending on design features such as belt guides, geometry and use of pretensioned belts (Bohman et al., 2022; Graci et al., 2022). Australian boosters, which typically include tethering and anti-submarining clips, have not been studied, and these features may affect outcomes. No crash data exist for rear or forward-facing CRS with reclined seats. To address these gaps, this study evaluated the effect of seatback recline on the crash performance of Australian Standards-approved rear and forward-facing CRS and high-back booster seats in frontal impact.

Conference theme
As emerging automated vehicle technologies make non-traditional seating configurations plausible, understanding the implications for occupant protection is essential. This work provides the first study to evaluate how current Australian CRSs perform in an emerging seating environment, ensuring evidence can guide proactive policy and design.

Method
Twenty-one frontal sled tests (27g, 49 km/h delta-V) were conducted on a standardised captain's chair using a load-limited, sash-pretensioned integrated seatbelt. A Q1 (ATD) was secured in the rear-facing CRS, and a Q6 ATD in the forward-facing CRS and high-back booster with an anti-submarining clip. Each CRS was tested twice at 21˚(baseline), 36˚, and 51˚seatback recline. High-speed side and overhead video was captured and used to quantify peak upward head excursion in rear-facing restraints and peak forward head excursion in forward-facing restraints and boosters. Peak head and chest acceleration, neck forces and moments, and lap belt force (booster seats only) were measured according to SAE J211 (Society for Automotive Engineers, 2014). Restraints were replaced if damaged. Three tests were excluded due to equipment issues and setup deviation. ATD sensor responses at recline angles of 36° and 51° were averaged and compared with the baseline average at 21° to evaluate the influence of recline. ATD submarining (booster seats only) and post-test CRS damage were qualitatively assessed using high-speed video.

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Results

Rear-facing restraints

Plastic deformation occurred in all tests, concentrated on the backrest sides and the seat base-back junction. Upward head excursion, HIC15, peak chest acceleration and neck tension all reduced with recline. Head acceleration increased at 51° and neck extension increased at both angles, most notably at 36° (Figure 1). Despite reductions in several metrics, most head and neck responses still exceeded recommended IARVs (EEVC, 2008). Only one 36° test remained below the maximum recommended thresholds for head acceleration and neck tension, and all tests exceeded the HIC15 limit.

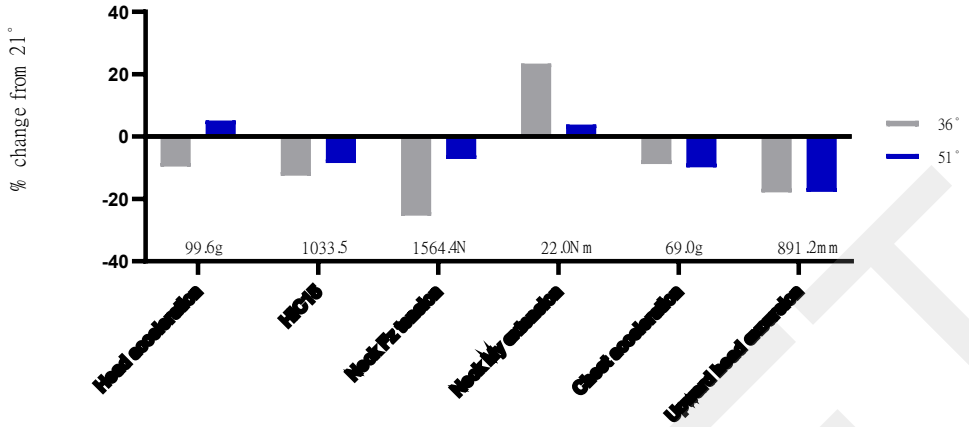

Figure 1. Effect of seatback recline on ATD responses and excursion in rear-facing restraints. Bars represent % change in mean value from 21° (baseline) condition. Mean 21° injury values are displayed above the x-axis

Forward-facing restraints

Harness slip, defined as the failure of the harness adjuster mechanism to maintain tension, occurred in both 51° tests and one 36° test. At 36° without harness slip, recline increased peak head acceleration, HIC15, and chest deflection. When harness slip occurred, responses were substantially reduced at both 36° and 51°, except head excursion which increased at both recline angles (Figure 2). Chest acceleration exceeded the maximum recommended IARV in one 21° and one 51° test.

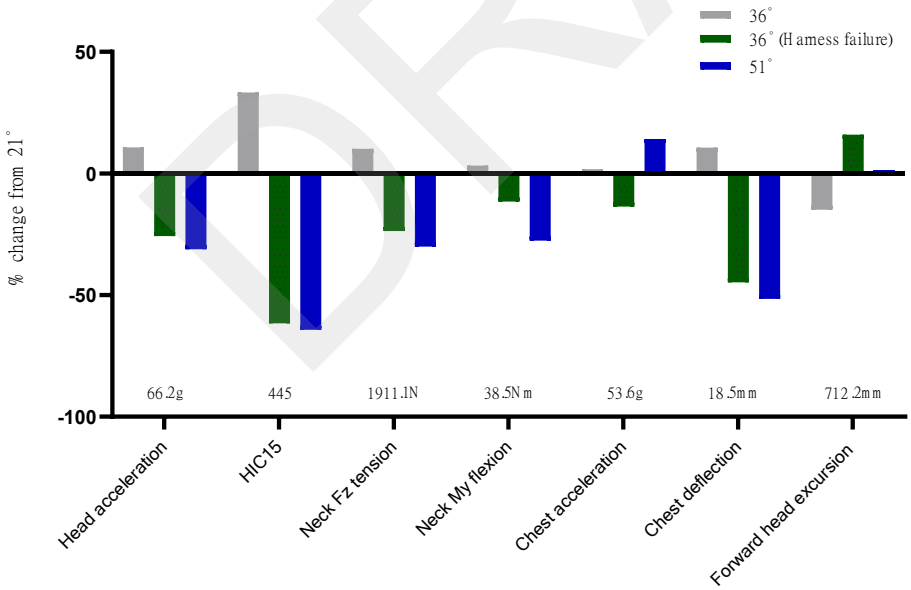

Figure 2. Effect of seatback recline on ATD responses and excursion in forward facing restraints. % change in mean of ATD response/excursion from 21° (baseline) condition. Mean 21° (baseline) injury values are displayed above the x-axis

Booster restraints

No submarining events were observed, and one hinge dislocation occurred at the seatback-base junction in the 51° condition. Increasing recline resulted in elevated head acceleration, HIC, chest acceleration, and neck flexion and

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tension compared to baseline. Knee-to-head displacement also increased as recline increased, while forward head excursion decreased. Peak neck tension exceeded the recommended maximum IARV at 51° (Figure 3).

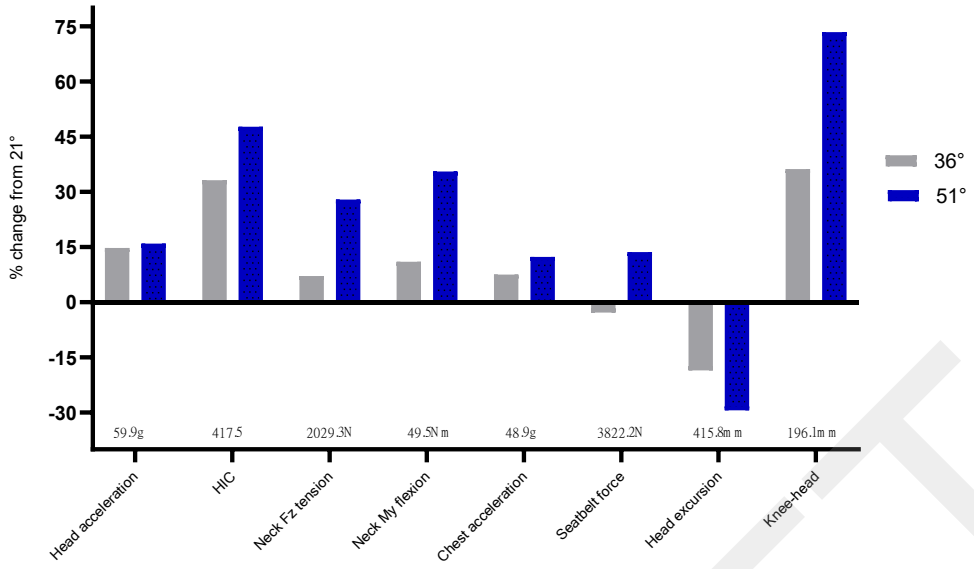

Figure 3. Effect of seatback recline on ATD responses and excursion in booster seats. Bars represent % change in mean value from 21° (baseline) condition. Mean 21° injury values are displayed above the x-axis

Benefits to road safety

Reclined seating can alter the performance of current CRSs, affecting kinematics, loading patterns and in some cases restraint integrity with potential implications for injury risk. Despite reductions in several metrics, head and neck injury risk remain a concern for rear-facing CRSs. Harness slip in forward-facing CRSs increased head injury risk. When harness integrity was maintained, although sensor metrics increased, these remained below critical injury thresholds. The absence of submarining in boosters may be attributed to the effect of the anti-submarining clip, however neck tension remains a concern with reclined seating. Further research is needed to validate this study's findings using production vehicle seats, a broader range of CRS designs, and deeper investigation of pretensioner use to ensure safe performance with different levels of reclined seating.

Implications for policy and/or practice

The findings highlight the need for integration of recline angles into test protocols, enhanced restraint design and development of evidence-based guidance for CRS use in reclined seats.

Conclusions

Reclined seating introduced restraint-specific changes in safety performance. These findings highlight the need to provide clear guidance for safety in recline and to develop restraint designs that manage altered kinematics. Addressing these issues will be essential to maintain child occupant safety as occupant seating design evolves.

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A randomised controlled trial of Dragon's Teeth on speed

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Abstract
Several low-cost treatment options have been proposed to mitigate speeding on highways on entry into regional towns. We evaluated one of these, a "Dragon's Teeth" treatment, using a randomised controlled design. The trial was prospectively registered. 3 sites out of 6 potential treatment sites were randomly selected to have a Dragon's Teeth treatment. The remaining 3 sites were control sites. Speeds were monitored using tube data. Speeds were assessed across the speed distribution at the 50th and 85th percentiles. For the main speed analysis at gateway sites, where the Dragon's teeth markings end and the speed limit is lowered, there were negligible changes in speeds during the day or night. These results suggest that it is very unlikely there would be a 5 km/h reduction in any part of the speed distribution profile due to the Dragon's Teeth treatment. A limitation of the current study is the small sample size.

Introduction
In regional towns along major highways, there is an issue with vehicles exceeding speed limits on entry into and within the townships. Several low-cost treatment options have been proposed to help in reducing speeds on highways where speed limits change. One treatment identified to be applied is Dragon's Teeth; a series of white triangles, clearly visibly perceptible, located on either side of the lane, just inside the lane markings, with the point of the triangle oriented towards the middle of the lane. Dragon's teeth markings are intended to slow drivers by creating a perceptual road narrowing effect. Such markings have been found to be effective in driving simulator studies. For example, Montella et al. (2011) found that Dragon's Teeth markings combined with transverse rumble strips led to a significant speed reduction of approximately 6 km/h when approaching an intersection compared with rumble strips only, and a reduction of ~20 km/h compared to no treatments.

The effectiveness of Dragon's Teeth markings have also been shown in on-road case studies. An earlier UK case series (UK Department for Transport, 2000) found that sites with Dragon's teeth installed demonstrated a range of speed reductions. However, sites also had countdown signs and other features installed. Recently, a Mexican study evaluated on-road speed behaviour at three high-speed to low-speed transition zones using dragon's teeth markings, transverse bars, or no markings (Hurtado-Beltran et al., 2025). They found a speed reduction of 12 km/h for dragon's teeth marking compared with transverse bars and unmarked sites. While promising, these on road studies have been small, focussing on a single site's change. Importantly, none of these studies have explicitly manipulated the assignment of treatment to location; i.e., studies have been uncontrolled before-after intervention evaluations, with sites specifically allocated to the intervention, which severely limits confidence in the results through severe selection biases. There are many issues with the conventional approach surrounding confounding of the causal relationship between treatments and outcomes (Albrecht, 2024; Albrecht & Hasan, 2025; Elvik, 2002). Unfortunately, randomisation of treatment allocation is rarely used (Elvik, 2021).

We evaluated a "Dragon's teeth" treatment using randomised allocation of sites to receive the road treatment, providing the first randomised controlled trial of Dragon's Teeth installations and one of the few randomised trials in road safety engineering research. By rigorously assessing the impact of Dragon's Teeth on vehicle speeds, the project aims to provide clearer evidence to support future deployment decisions.

Conference theme
Only through the highest quality evidence can we make the best decisions about roads treatments to reduce harm. Ineffective interventions challenge road safety through diversion of resources away from more effective interventions. To combat this in the future, randomised controlled trials need to be more widely embedded in our evaluations of road safety treatments. We need to educate organisations responsible for rolling out road safety interventions to the advantages of high-quality evaluations. The future of road safety evaluation should also include pre-registration.

Method

Experimental design
The study was a randomised controlled trial of Dragon's Teeth effects on speed along a major Western Australian Highway. The study was pre-registered at Open Science Foundation (Albrecht et al., 2024 #hs845). Ethical approval was obtained by the University of Western Australia Human Research Ethics Committee.

Sites

A pool of 6 sites were identified for which the Dragon's teeth treatment could be applied. From this pool of 6 sites, 3 were randomised to receive the Dragon's Teeth treatment using the random number generator in R version 4.3.2 (R Core Team 2024). Surveys were collected at 4 time points, including one pre-installation collection (baseline), and three after surveys. Surveys were planned to be as close to 1, 3, & 6 months after installation as possible. The actual timing was ~1, 4, & 8 months post-treatment.

Speed assessment

The primary outcome measure was speed. Speed measurements at each township were recorded using pneumatic tube counters consisting of two strips placed ~1 m apart across the road, installed by Surveytech. Data were extracted such that each row was a vehicle and contained its timestamp, speed, bearing, and quality. Counts/speeds with quality indicators < 100% were removed.

Analysis

Tube and Compass IoT data were imported into R version 4.5.2. For locations West of the township, only East-going vehicles were included, and vice versa for locations East of the township. Speeds less than 0.01% and above 99.99% of the total speed distribution were removed. Primary outcome variables were 50th% and 85th% speeds. Secondary outcome variables included 95th% speeds. Quantiles were calculated using the quantile function in R for each town, location, time point, direction of travel, daytime vs nighttime, and weekday vs weekend. This abstract focusses on weekday day time speeds as this captures the most data.

Mixed-effects regression models were used per the pre-registration (Albrecht et al. 2024). Town was treated as a random effects term/cluster variable. Baseline recordings were used as a covariate for the respective speed quantiles (i.e., the 50th% speed baseline was the covariate for the 50th% speed outcome), with treatment allocation (Dragon's Teeth installed vs Control) the primary independent variable of interest. Time was included as a factor and the interaction between time and treatment was included in the modelling, but only the overall effect of treatment is reported here. A minor deviation from the pre-registration analysis protocol included "location" as a factor in the model as each Town has the treatments installed on two-legs (East and West).

Results

Figure 1 presents the aggregate means ± standard errors (SE) for all vehicles. Table 1 presents the primary contrast between treated and control sites for daytime speeds (Daytime was defined as 7:00 to 18:00), separated by weekdays and weekends. There were no statistically significant speed reductions at any part of the speed distribution, with the estimated mean speed reductions being close to 0 and generally excluding a 5 km/h reduction.

Table 1. Speed analysis: Estimated marginal means comparing treated sites and control sites averaged over all post-treatment time points

Weekday/Weekend	Day/Night	Speed %	Effect	Mean (km/h)	CI l95	CI u95	p
Weekday	Day	50th %	Control	72.3	70.3	74.4	
			Treated	71.4	69.4	73.4	
			Contrast	**-1.0**	**-3.8**	**1.9**	**0.52**
		85th %	Control	82.3	79.4	85.2	
			Treated	81.7	78.8	84.5	
			Contrast	**-0.6**	**-4.7**	**3.5**	**0.78**
Weekend	Day	50th %	Control	72.8	70.7	75.0	
			Treated	71.9	69.8	74.0	
			Contrast	**-0.9**	**-4.0**	**2.1**	**0.55**
		85th %	Control	83.1	79.7	86.4	
			Treated	82.6	79.2	86.0	
			Contrast	**-0.4**	**-5.3**	**4.4**	**0.86**

Benefits to road safety

The results from this trial can be used to inform treatments for speed at gateway locations along major highways. Ultimately, Dragon's Teeth treatments are unlikely to be considered an effective speed reduction tool and resources can be re-directed to other interventions that are more effective.

Implications for policy and/or practice

Embedding randomised controlled designs into policy and practice can aid more rapid re-allocation of resources towards more effective interventions. Additionally, pre-registration of studies can reduce the file drawer problem in road safety as shown in other fields (Lakens et al., 2024).

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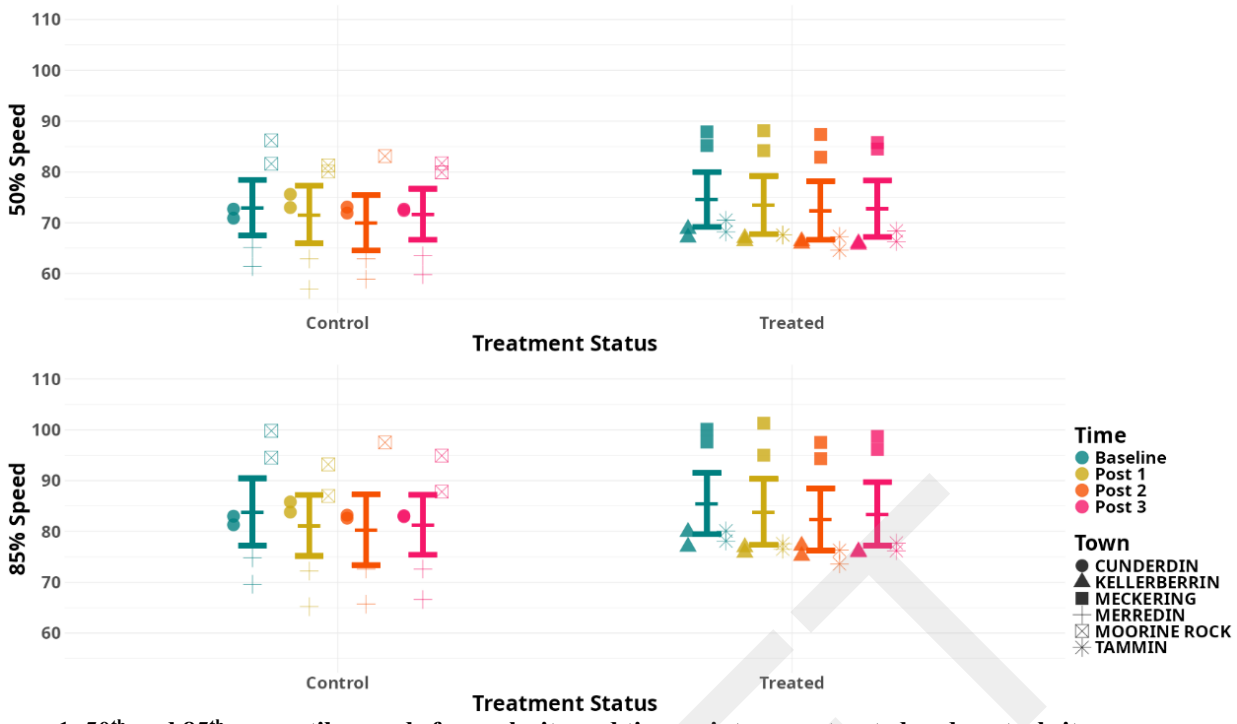

Figure 1. 50th and 85th percentile speeds for each site and time point across treated and control sites

Conclusions

In the most rigorous study of the on-road ability of Dragon's Teeth treatments to reduce speed conducted so far, we show little impact of Dragon's Teeth treatments on speeds at gateway sites into regional towns. Other treatments should be considered.

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Validation of iRAP Star Rating Protocol: Philippine Highway case study

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Abstract
This study assessed the validity of the iRAP Star Rating protocol by comparing Vehicle Occupant Star Ratings with actual crash rates on a Philippine Highway Corridor, focusing on two-lane and four-lane undivided roads. Results confirmed the validity of iRAP Star Ratings on two-lane undivided roads. However, a counterintuitive relationship was observed on four-lane undivided roads, where higher Star Ratings were associated with higher crash rates. The current iRAP model assumes that overtaking on the opposing direction is reduced on multilane roads. In contrast, this study found that opposing direction crashes were the second most prevalent crash type along the subject corridor. This finding suggest that the current iRAP methodology may systematically underestimate crash risks on four-lane undivided roads in similar traffic environments. The findings highlights opportunities for context-sensitive improvements to enhance the accuracy of the iRAP assessments.

Introduction
Road crash fatalities in the Philippines rose sharply from 6,869 in 2006 to 11, 292 in 2016, reflecting a 64% increase and annual average of 4.8% over a decade. This trend underscores the alarming road crash trauma in the country. Despite the public demand for safer roads, the Philippine government currently lacks operational crash data system, and the former system, the Traffic Accident Recording and Analysis System (TARAS), has not been operational since 2013. In this regard, the Philippines shifted toward a proactive approach by adopting the International Road Assessment Program (iRAP) Star Rating Methodology as a key road safety performance indicator under the Philippine Road Safety Action Plan (2023-2028).

Given the policy shift, the study examines the validity of iRAP Star Ratings in the Philippine context with real-world safety outcomes by utilizing crash records from police reports in the Philippine National Police (PNP) Electronic Blotter System. The analysis focused on Vehicle Occupant (VO) Star Ratings along two- and four-lane undivided sections of the 428.2-km Cagayan de Oro–Davao–General Santos Highway in the southern Philippines.

Conference theme
The study directly aligns to the QRSC2026 theme, by strengthening the empirical foundation of proactive road safety assessment. In countries with no road crash database system, the use of proactive tools such as the iRAP Star Rating Methodology are widely adopted to guide road infrastructure safety improvements. Ensuring that these tools lead to effective applications requires validation against real-world crash outcomes, particularly when applied in contexts different from those countries, which they were originally modelled and developed.

Method
The study analyzed three analysis periods: (1) a 5-year aggregate (2016–2020), (2) a 3-year pre-survey period (2016–2018), and (3) a 3-year post-survey period (2017–2019) to examine long-term trends, establish baseline conditions prior to the survey, and assess changes following the survey implementation in 2017. Crash datasets were pre-processed to extract essential details, such as the type of vehicles involved and the traffic dynamics, referring to the movement, interaction, and relative positions of the vehicles involved, which helped determine the nature and type of crash. A Geographical Information System (GIS) software was used to integrate road crash data with VO Star Ratings through the spatial joining of iRAP Star Rating data and crash occurrence records. VO crash rates were calculated per 100-m segments of the iRAP road data and expressed in crashes per 100 million vehicle kilometers travelled (MVKT). Box plots were used to visualize the distribution of crash rates across Star Rating levels under different roadway conditions. Star Ratings and crash rates were compared across combinations of carriageway type, area type, speed limit, and curvature type to ensure that the roads were homogeneous in nature and to enhance the reliability of the analysis. For each combination, the individual crash rates of the 100-m segments were averaged per Star Rating level. A Negative Binomial (NB) Generalized Linear Model (GLM) was used to evaluate the statistical significance of the relationship between crash rates and iRAP Star Ratings across varying road conditions. Star Ratings were treated as categorical variables, with each level representing a distinct category, to allow for a comparison of crash rates across different Star Rating levels.

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Results

For four-lane roads, the results show a counterintuitive relationship between the iRAP Star Ratings and crash rates, where higher Star Ratings are associated with higher crash rates (Figure 1). However, an exception was observed in Case 22E, where crash rates significantly decreased with higher Star Ratings. Road segments rated with 1-Star consistently showed the lowest mean crash rates across the three analysis periods. In contrast, 3-Star segments exhibited the highest mean crash rates in most cases, particularly when considering non-zero values, whereas 2-Star segments fell in between but still exceeded the mean crash rates of 1-Star segments.

Several cases (1E, 3E, 8E, 15E, 16E, and 20E) showed significantly increasing trends for both Star Rating comparisons. Additional cases (4E, 6E, 18E, and 24E) showed a significantly increasing trend only for the 3-Star versus 1-Star Rating variation, while a few cases (5E, 11E, and 12E) exhibited marginally for the 2-Star versus 1-Star comparison.

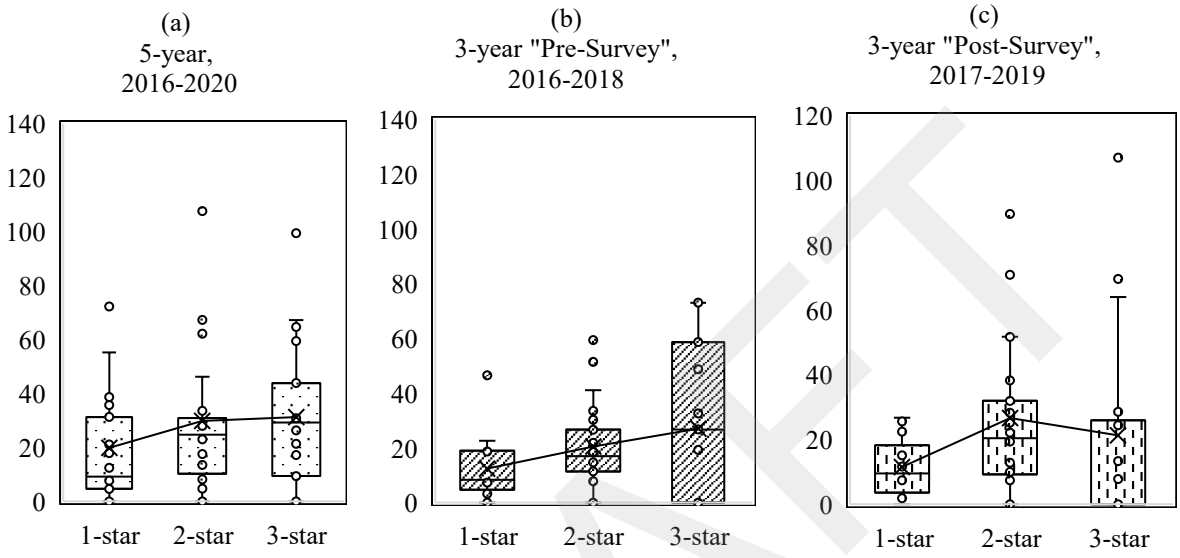

Figure 1. Four-lane Undivided Roads (4U) with at least three levels of VO Star Ratings

For two-lane undivided roads, the patterns support the hypothesis. The 1-Star segments showed the highest mean crash rate across all periods. In contrast, 2-Star segments demonstrated intermediate mean crash rates, whereas 3-Star segments exhibited the lowest mean crash rates for the 5-year and post-survey periods. The pre-survey period, however, shows a slight inconsistency with the expected hypothesis, since there is a 0.84 increase from the 2-Star to the 3-Star segments.

Several cases (2F, 9F, 18F, and 22F) were statistically significant for both Star Rating comparisons. However, some cases (4F, 9F, 10F, 20F, and 23F) showed marginal statistical significance for at least one comparison. These findings were observed on road segments with moderate speed limits (60 kph), indicating a stronger alignment between the Star Ratings and crash outcomes in that context.

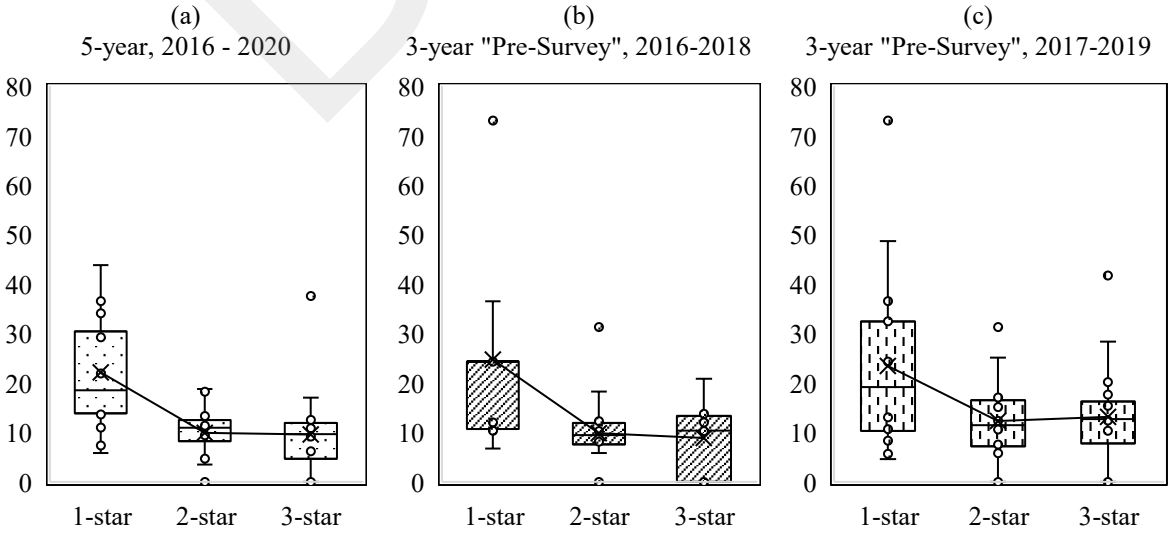

Figure 2. VO Crash Rate Distribution by Analysis Period and VO Star Rating (2U)

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Verification results using the iRAP ViDA Software Demonstrator Tool by comparing undivided and divided four-lane road configurations indicate that, under the current iRAP assessment protocol, the presence or absence of a median had a minimal influence on the Star Ratings for four-lane roads. In checking this observation with iRAP, it was noted that the current model assumes that overtaking into opposing lanes is reduced on multilane roads.

However, the observed crash data showed that opposing-direction crashes were the second most prevalent crash type along the study corridor. Therefore, the results suggest that the current iRAP methodology may systematically underestimate crash risks on four-lane undivided roads in environments where opposing-direction conflicts remain significant. This highlights the need for context-sensitive improvements to enhance the accuracy of the iRAP assessments.

Benefits to road safety

Despite the contradictory results observed in the data analysis, the findings of this study highlight opportunities for improvement and do not undermine the value of the iRAP Star Rating Methodology. The iRAP approach is valuable because it prioritizes vulnerable road users, such as bicyclists and pedestrians, in addition to vehicle occupants and motorcyclists. It also provides a standardized and proactive framework for assessing road infrastructure risk, which is essential in countries with limited or no road crash data, such as the Philippines. In addition, iRAP provides cost-effective countermeasures and facilitates strategic road safety investment planning (Murozi, 2022), making it a powerful tool for risk identification and, more importantly, for making informed investment decisions.

Implications for policy and/or practice

The observed inconsistencies between iRAP Star Ratings and crash rates on four-lane roads indicate the need for context-specific calibration of the iRAP risk model, to better account for operational risks associated with opposing-direction overtaking and local driving behaviour. Policymakers and government agencies may use the findings to refine how the iRAP methodology is applied within the Philippine context and similar road environments, especially when prioritizing investments on multilane roads.

Conclusions

The study validates the iRAP Star Rating Protocol for two-lane undivided roads, where higher Star Ratings correspond to lower crash rates. However, on four-lane undivided roads, a counter-intuitive pattern was observed, with higher Star Ratings associated with higher crash rates. Analysis revealed that the prevalence of opposing-direction crashes along the subject corridor contributes to this discrepancy, a factor not fully captured by the current iRAP model, which assumes reduced opposing-direction overtaking on multilane roads. This highlights the need for context-sensitive improvements to enhance the accuracy of the iRAP assessments.

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CycleRAP in Perth using AiRAP methodology

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Abstract
Road agencies are increasingly shifting from reactive crash-based analysis toward proactive infrastructure risk assessment to better protect vulnerable road users. CycleRAP provides a rapid and objective method for identifying cycling-infrastructure risk without relying on crash history, using more than 45 infrastructure and contextual attributes to generate comparable risk scores across four crash types. In 2025, Main Roads WA integrated CycleRAP with AiRAP methodology to enable automated data capture, processing and network-level evaluation of over 300 km of Principal Shared Paths (PSP). Using an e-tricycle scanning platform equipped with LiDAR and 360° imagery, the project collected infrastructure, surface and visual data to produce CycleRAP Star Ratings. Although the results reveal substantial portions of the network with low to medium risk, there remain high and extreme risk locations, highlighting opportunities for targeted improvements. The study demonstrates how automation can scale infrastructure safety assessment and support proactive cycling-safety management.

Background
Road safety practice is increasingly moving from reactive, crash-based analysis toward proactive assessment of infrastructure risk, particularly for vulnerable road users such as cyclists. Traditional safety management approaches rely heavily on historical crash data to identify high-risk locations. However, this approach has limitations for cycling because many bicycle crashes are under-reported in police databases, and a significant proportion of incidents recorded in hospital data do not appear in official crash statistics (Watson et al. 2015). Consequently, relying solely on crash history may underestimate cycling risk and delay the identification of locations requiring safety improvements.

CycleRAP, developed by the International Road Assessment Programme (iRAP), addresses this challenge by providing a structured infrastructure-based risk assessment framework for cycling facilities. CycleRAP evaluates risk independently of crash data using more than 45 infrastructure and contextual attributes describing facility design, surrounding environment, traffic conditions and user interactions (iRAP, 2022). These attributes are used within a risk model to estimate the likelihood and severity of four crash types: vehicle–bicycle, bicycle–bicycle, bicycle–pedestrian and single-bicycle crashes. The resulting scores provide consistent and comparable measures of cycling-infrastructure risk that can be used to prioritise safety improvements.

At the same time, advances in automated data collection and processing technologies are transforming how infrastructure safety assessments can be undertaken. The Accelerated and Intelligent Road Assessment Program (AiRAP) framework demonstrates how automation, computer vision and multi-source data integration can support scalable, repeatable and cost-efficient safety assessments (iRAP, 2023). By extracting infrastructure attributes from LiDAR and imagery data, AiRAP reduces the time and resources required for traditional manual surveys while enabling more frequent network-wide safety monitoring.

In 2025, Main Roads Western Australia in collaboration with Anditi integrated these two approaches by applying an AiRAP-based methodology to undertake a CycleRAP assessment of more than 300 km of the state's Principal Shared Path network. Data were collected using a pedal-assisted e-tricycle scanning platform, equipped with dual laser scanners and a 360° camera, allowing the survey team to capture detailed geometric, surface and contextual information while operating safely within the shared-path environment. This project represents one of the first known applications globally to operationalise CycleRAP using automated data capture and processing at a network scale.

Conference theme
This project transforms high-quality automated infrastructure data into actionable safety insights for cycling. By combining CycleRAP with AiRAP, it shifts from reactive crash analysis to proactive risk identification and provides objective Star Ratings to support targeted investment and treatment prioritisation. The work directly aligns with the ARSC2026 theme by demonstrating how evidence-driven methods can accelerate meaningful action toward a safer transport future.

CycleRAP Assessment Methodology
CycleRAP assesses cycling-infrastructure risk through three components: crash initiation, crash likelihood, and crash severity. Crash initiation describes how an incident begins—such as avoidance manoeuvres, loss of control from speed

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or surface conditions, or impact with other road users (iRAP, 2022). Each initiator has associated crash triggers, which are the specific conditions required for a crash to occur, including obstacles, narrow paths, other users, or surface features. Where triggers exist, contributing factors—such as limited space, poor surface quality, crowding, or restricted visibility—are evaluated for their influence on crash probability (Ahmed et al., 2025).

Once a crash scenario is defined, CycleRAP classifies the likely outcome into one of four crash types: vehicle–bicycle, bicycle–bicycle, bicycle–pedestrian, or single-bicycle. Severity is then estimated using determinants such as gradient, operating speed, proximity to traffic, heavy-vehicle exposure, roadside hazards, and other contextual elements affecting injury outcomes. The model uses more than 45 coded attributes covering infrastructure, context, movement patterns, speeds, and user counts. These inputs are combined through a multiplicative scoring system based on international crash-risk evidence, producing crash-type-specific risk scores and an overall CycleRAP score categorised as low, medium, high, or extreme.

CycleRAP Data Capture

CycleRAP data for Main Roads was collected using a pedal-assisted e-tricycle scanning platform designed to safely operate within the Principal Shared Path (PSP) network without requiring path closures or disrupting users. This approach allowed the survey team to move naturally within the cycling environment and capture the infrastructure conditions needed for CycleRAP's risk-assessment model. Figure 1 shows the scanning setup used for the project.

Figure 1. Bike (left) and Scanners (right) used for CycleRAP data collection

The e-tricycle carried a compact sensor system including dual laser scanners and a 360° camera, which together recorded the path width, surface condition, sight lines, markings and surrounding context needed to understand bicyclist risk factors. Because the system moved at typical cycling speeds, it could capture long corridors efficiently while maintaining safety for both the survey team and other PSP users.

A single pass along each PSP segment was sufficient to gather the geometric and visual information required for CycleRAP. The method ensured consistent, high-quality coverage across the network while avoiding the operational impacts associated with vehicle-based surveys. The resulting point-cloud data and panoramic imagery provided the full evidence base for assessing crash-related features such as obstacles and side hazards—core inputs into the CycleRAP risk evaluation process.

Results

The initial findings show that most of the PSP network falls within the medium risk category, indicating generally favourable safety conditions for cyclists (Figure 2). However, around one quarter of the assessed network was rated as high or extreme risk, signalling locations where targeted infrastructure upgrades may be necessary. Crash-type patterns were broadly consistent for bicycle–bicycle, bicycle–pedestrian and single-bicycle crashes, with most segments classified within medium-risk bands (Figure 3). In contrast, the risk profile for vehicle–bicycle crashes differed notably. Elevated risks are concentrated at points where cyclists interact directly with motor vehicle traffic—such as road crossings or sections where the shared paths run alongside roadways without sufficient separation. These outcomes underscore the critical role of managing cyclist–vehicle interactions as a central strategy for enhancing cycling safety.

Benefits to road safety and next steps

Main Roads' application of AiRAP for CycleRAP assessments provides significant value for proactive cycling-safety management in Western Australia and internationally. CycleRAP Star Ratings offer an objective and consistent baseline for assessing cycling risk across diverse facility types. This enables clearer, evidence-based discussions with local governments, planners and advocacy groups on locations where risk is elevated and the underlying contributing factors need to be addressed.

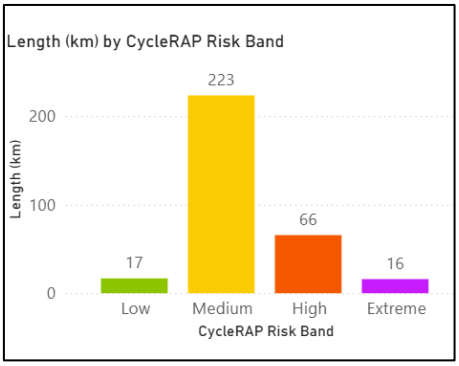

Figure 2. Overall CycleRAP score for the assessed PSP network in Western Australia.

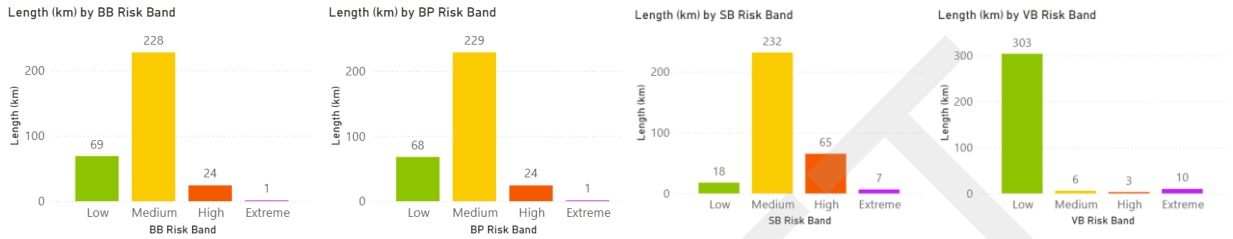

Figure 3. Results for each CycleRAP Crash type by length. Bicycle–bicycle (BB), bicycle–pedestrian (BP), single-bicycle (SB) and vehicle-bicycle (VB) crashes.

AiRAP's automated processes also allow ratings to be updated as network conditions change, supporting continuous improvement in planning, asset management and program evaluation. CycleRAP fills a longstanding gap in bicycle-infrastructure assessment by identifying risk independently of crash data—addressing the well-documented under-reporting of bicycle crashes and the high proportion of hospitalisations not recorded in police databases (iRAP, 2022). Combining forward-looking risk metrics with traditional crash-based evidence will help identify high-risk locations, diagnose key contributing attributes, and track treatment benefits through periodic reassessment.

With CycleRAP Star Ratings completed, the next phase is to translate results into targeted, stakeholder-supported safety improvements. Early priorities include engagement with local governments, advocacy groups and planning partners to build a shared understanding of cycling risk patterns. Furthermore, additional assessments of other priority cycling routes (not on the Primary Shared Path network) should be considered.

Conclusions

Applying the AiRAP methodology to CycleRAP assessments enabled a consistent and scalable evaluation of cycling-infrastructure safety across Western Australia's Principal Shared Path network. The automated data-collection and processing workflows support repeatable network-wide monitoring and provide a stronger evidence base for identifying high-risk locations and prioritising safety improvements.

Beyond Western Australia, the study demonstrates how combining automated infrastructure data collection with established risk-assessment frameworks can significantly expand the scale and efficiency of cycling-safety assessments. As more road agencies seek proactive approaches to managing vulnerable road user safety, integrating AiRAP with CycleRAP provides a promising pathway for improving cycling-infrastructure planning and reducing injury risk across active transport networks.

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DRAFT

Estimating bicycle flows for accurate Cyclist Risk Assessment

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Abstract
Reliable cyclist exposure data is essential for accurate road-safety assessment, yet such data remains limited and inconsistent across many cities. In Perth, available cyclist information is fragmented and mostly short-term, making it difficult to identify high-use corridors and prioritise safety interventions. This study applies the DQ Flows transport-modelling approach to estimate cyclist (and pedestrian) volumes across the Perth metropolitan network. The model integrates population characteristics, mode-split information, and route-choice behaviour to generate network-wide flow estimates, which are validated against observed count data, showing strong agreement. Results show that cycling activity is concentrated along key corridors such as principal shared paths and routes connecting major activity centres. By providing consistent, spatially detailed exposure estimates, the modelling approach strengthens cyclist risk assessment and improves the integration of cyclist exposure into infrastructure safety frameworks, including AusRAP and CycleRAP. Findings support more evidence-led and equitable safety planning for vulnerable road users.

Background
Understanding cycling travel patterns is essential for achieving equitable and effective road safety outcomes. Infrastructure risk assessment involves more than identifying physical hazards; it also requires understanding who uses the network, where they travel, and how their exposure interacts with infrastructure design (iRAP, 2024). Reliable information on cyclist movements is therefore critical for accurate risk modelling and informed safety planning.

In Perth, cycling serves several key purposes, including commuting to employment centres, accessing schools and shops, recreational and fitness riding, and providing first- and last-mile connections to public transport. Cycling activity is typically concentrated along principal shared paths (PSPs), coastal routes, activity centres and major corridors linking suburbs to the central business district. Temporal patterns are also observed, with higher cycling volumes during weekday commuting periods and on weekends, when recreational riding is more common.

Despite the increasing role of cycling in urban mobility, reliable cyclist exposure data in Perth remains limited. In contrast to motor vehicle traffic—supported by comprehensive AADT datasets and long-established counting programs—cycling data is often fragmented, geographically limited and based on short-term counts. Census journey-to-work data suggest that cycling represents a modest but meaningful share of travel, but these figures underestimate total activity because recreational and non-work trips are not captured. Without continuous, network-wide monitoring, the true distribution and intensity of cycling exposure remain uncertain. Within current AusRAP star rating systems, cyclist volumes are often estimated using video surveys, the iRAP pre-processor, or other internal estimation methods. This can lead to cyclist exposure being underrepresented, meaning corridors with moderate vehicle traffic but high cycling activity may be overlooked when prioritising safety improvements.

The DQ Flows cyclist model provides a practical approach to addressing this challenge by estimating cycling volumes across the entire network. Using an advanced transport modelling framework, DQ Flows simulates bicycle and pedestrian movements based on population characteristics, travel behaviour and network structure. The results are presented as flow maps and datasets through an online platform, enabling users to visualise and analyse cycling (and pedestrian) activity across the network. By generating reliable, location-specific exposure estimates, DQ Flows helps agencies improve risk modelling and support a shift toward more balanced, multimodal road safety assessment.

Conference theme
This study directly aligns with the ARSC2026 theme by showing how improved cyclist exposure data can transform incomplete evidence into actionable road-safety improvements. As active transport grows in importance for urban mobility and public health, safety systems must reflect real travel behaviour. Integrating continuous cyclist monitoring into star-rating frameworks enables agencies to make more informed investment decisions, target safety interventions more effectively, and achieve measurable safety outcomes.

The DQ Flows Approach to Estimating Cyclist Volumes
DQ Flows applies a transport-modelling framework to estimate where cyclists are most likely to travel across a road network. The model simulates cycling movements between origins and destinations by incorporating population characteristics, behavioural profiles and the structure of the transport network (DOK Data B.V., 2025). It considers

residents within the study area as well as those from surrounding regions to capture key trip origins and destinations, including residential areas, workplaces, schools and commercial centres.
The model also accounts for factors that influence travel mode and route choice (DOK Data B.V., 2025). Regional mode-split data are used to estimate the proportion of trips made by bicycle, while the routing engine evaluates network attributes such as connectivity, gradients and route quality to replicate realistic route selection. Using these inputs, the model distributes cycling trips across the network and aggregates them into estimated flows for each road segment. It also maps cycling trips associated with public transport journeys, particularly travel to and from train stations.

The output consists of a network-wide dataset showing expected cycling volumes and travel patterns. These results are presented as flow maps and downloadable datasets through an online platform, allowing users to visualise cyclist intensities, identify high-demand corridors and export data for further analysis. This provides planners and road-safety practitioners with clearer insights into cyclist exposure across the network.

When combined with observed bicycle count data, the model can be calibrated and validated. Count locations act as reference points, enabling relative flow estimates to be converted into absolute cyclist volumes and allowing observed counts to be extrapolated across the entire network. As a result, the model can extrapolate observed counts across the entire network, producing maps in which each road segment is assigned an estimated numerical cycling volume rather than only relative flow intensities.

Results

This study estimated the volumes of both cyclists and pedestrians using the DQ Flows TM model; however, only the cyclist results are presented in this paper. Figure 1 shows the DQ Flows output for Tuesday morning peak and weekday cycling volumes focused on Perth Central Business District.

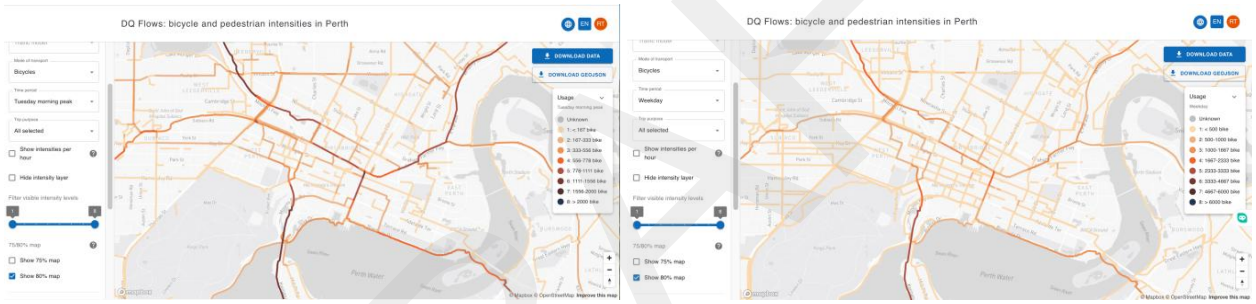

Figure 1. Tuesday Peak cycle count (left) Weekday cycle count (right) for Perth CBD.

Result Validation

Bicycle count data from 54 locations were used to validate the estimated cyclist flows produced by the model. Overall, the validation results indicate good agreement between the modelled and observed data. Figure 2 provides a visual comparison, where lines represent modelled flows and circles indicate observed count locations. Colour intensity reflects flow magnitude, with darker colours representing higher cyclist volumes. At most locations, the modelled and observed values align closely, suggesting that the model captures the spatial distribution of cycling activity reasonably well.

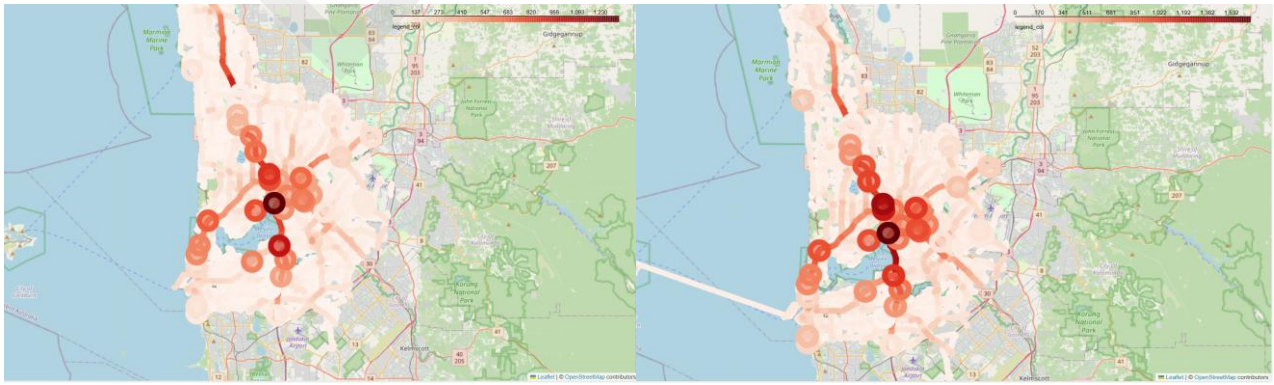

Figure 2. Validated cycle counts for the Tuesday morning peak (left) and validated cycle counts for weekdays (right)

A statistical validation was also conducted using two methods. The first method was the Root Mean Square Error (RMSE), which measures the average magnitude of the differences between predicted and observed values. The RMSE

was 268 for the Tuesday morning peak and 307 for the weekday model, indicating relatively small prediction errors given the scale of the flows. The second validation method examined differences in flow classes between modelled and observed data. The flows were grouped into both 5 and 8 classes to assess how well the model reproduced relative flow patterns across the network. For the Tuesday morning peak using 8 classes, 26% of locations showed a difference of more than one class. When divided into 5 classes, 16 of the 54 locations (30%) had a one-class difference, and only 2% had a difference greater than one class. For the weekday model, performance was stronger. Using 8 classes, only one location showed a difference greater than one class. When grouped into 5 classes, four locations (7%) had a one-class difference, and none exceeded this.

Although the RMSE for the Tuesday morning peak is slightly lower, this largely reflects the smaller flow volumes within the 2.5-hour peak period. The weekday model demonstrates stronger spatial agreement, likely because full-day counts provide larger data volumes and smoother flow patterns than short peak-period observations.

Benefits to Road Safety and Implications for Practice

This study contributes to road safety practice by addressing the long-standing challenge of limited cyclist exposure data. By generating network-wide cyclist flow estimates, DQ Flows helps road authorities better understand where cyclists travel, where they face the greatest risk, and where safety interventions will be most effective. Integrating these exposure estimates with frameworks such as AusRAP and CycleRAP improves risk modelling and supports evidence-based prioritisation of safety improvements. The findings also assist transport planning by providing reliable data to guide investment in cycling infrastructure and safer road environments. Overall, the study supports a shift from vehicle-focused safety assessment toward a more balanced, multimodal approach to road safety.

Lessons Learned

The application of the DQ Flows transport modelling approach provides valuable insights for cyclist exposure analysis and infrastructure risk assessment. The study highlights a major gap in reliable cyclist volume data, which is often fragmented and limited compared with established vehicle traffic datasets such as AADT. The modelling results show that cycling activity is concentrated along specific corridors, including shared paths, coastal routes and connections to major activity centres, where cyclist exposure to risk is higher. DQ Flows offers a practical and scalable method for estimating cyclist volumes across an entire network by incorporating population characteristics, mode share assumptions and realistic route choice behaviour. Integrating these exposure estimates into road safety frameworks such as AusRAP and CycleRAP can strengthen risk modelling and support more informed safety decisions and equitable infrastructure investment.

Future Work

This study represents an initial application of the DQ Flows methodology to estimate cyclist exposure across the Perth metropolitan network, with a primary focus on cycling movements. Ongoing work includes validating pedestrian flow estimates using observed count data. The current analysis relies solely on the Traffic Model (TM) component of DQ Flows and does not yet incorporate the GPS-based model.

The GPS model uses large datasets of time-stamped GPS traces. DQ Flows has developed algorithms to detect and classify bicycle and pedestrian movements within these datasets. This approach has already been applied in the Netherlands, where validation studies show that combining GPS-based observations with the transport-model component delivers the strongest predictive performance. Future research will explore integrating GPS data further to improve model calibration and accuracy for the Perth network.

Beyond estimating current flows, the transport-model component can also be used to evaluate future scenarios. The model can simulate the effects of changes in modal split or infrastructure, such as new bridges, tunnels or cycling routes. When combined with GPS data, it also enables monitoring of how cycling and walking patterns evolve, providing valuable insights into the impacts of infrastructure investments and policy initiatives.

Conclusions

This study demonstrates that transport-modelling tools such as DQ Flows can effectively address gaps in cyclist exposure data by producing reliable, network-wide flow estimates validated against observed counts. Incorporating these exposure metrics into existing infrastructure safety frameworks improves the identification of high-risk corridors and supports more targeted, evidence-based safety investments. The findings reinforce the importance of integrating cyclist exposure into risk-modelling processes to ensure road-safety decisions reflect the needs of vulnerable road users.

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From local evidence to safer School Precincts

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Abstract
School precincts present heightened road safety risks for children, particularly during peak arrival and departure periods. Fast-growing municipalities with many schools, diverse contexts and limited resources require systematic, scalable responses. This paper describes the development of *A Practical Guide to Safer School Precincts*, translating local evidence into a consolidated framework and tiered delivery model. Informed by Monitoring, Evaluation and Learning, practitioner experience, and cross-sector input, the Guide uses a structured diagnostic process to align proportionate responses across six integrated pillars: education and awareness; engineering and the built environment; enforcement and compliance; encouragement and active travel; engagement and collaboration; and evaluation and learning. Delivered through problem-based modules and tiered support, the framework enables consistent, equitable action across diverse school settings, extending reach within finite resources and strengthening school precinct safety outcomes.

Background
School precincts are recognised as high-risk road environments for children, particularly during school arrival and departure periods when traffic volumes and conflicting movements increase. Children are over-represented among vulnerable road users, with pedestrians accounting for approximately 17% of road fatalities in Victoria and thousands of serious pedestrian injuries recorded annually (Transport Accident Commission [TAC], 2025).

Rapid urban growth further compounds these risks. In fast-growing municipalities with large numbers of schools, councils face increasing pressure to manage complex pickup and drop-off behaviours, rising traffic volumes, and diverse built environments, often with limited resources. These conditions highlight the need to move beyond fragmented or reactive measures towards more systematic, evidence-based approaches that can be applied consistently while remaining responsive to local context.

Conference theme
This work directly addresses the ARSC 2026 theme *From Evidence to Action: Shaping a Brighter Future* by demonstrating how local data and evaluation findings can be translated into consistent, scalable action. The Guide moves beyond fragmented or ad-hoc interventions by operationalising evidence into structured decision-making tools that support proportionate responses across diverse school settings, enabling practical action at scale.

Project description
A Practical Guide to Safer School Precincts was developed between May 2024 and December 2025 to translate local evidence, Monitoring, Evaluation and Learning (MEL) findings, and practitioner experience into a practical, scalable framework and delivery model for improving safety and movement around schools. Designed for councils and partner agencies, the Guide consolidates lessons from our existing program into a structured, transferable model that supports consistent and equitable decision-making.

The Guide is grounded in a shared vision that everyone has a role in getting children to school safely, positioning school precinct road safety as a collective responsibility of councils, schools, families, communities, and government agencies. Delivery is guided by six principles: shared responsibility; equity and inclusion; community-led change; proportionate administration; evidence-informed decision-making; and whole-system thinking.

A multi-pronged approach underpins the Framework, integrating six interconnected pillars: education and awareness; engineering and the built environment; enforcement and compliance; encouragement of active travel; engagement and collaboration; and evaluation and learning. Rather than relying on isolated interventions, the Framework emphasises coordinated action to address behavioural, environmental, and systemic contributors to risk, including congestion, unsafe behaviours, and barriers to active travel.

The School Road Safety Program Model operationalises the Framework through a repeatable delivery cycle: diagnose local issues; match problem-based modules; agree on actions with schools; plan and sequence activities; implement interventions; monitor progress; adapt responses; and review and learn. Delivery is tiered (Universal, Selective, or Intensive), enabling efficient use of limited resources while maintaining consistency and equity across schools.

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Development involved collaboration with Victoria Police, health partners, the Department of Transport and Planning, the Victorian School Building Authority, internal council teams, and school communities to ensure responses are practical, acceptable, and feasible. Designed as a transferable resource, the Guide has been disseminated to councils nationally, supporting broader uptake of a consistent, evidence-informed approach to school precinct safety and embedding of the Framework within routine council operations.

Findings

The evaluation period informed the finalisation of A Practical Guide to Safer School Precincts, which now provides a consolidated framework and tiered delivery model. Findings from this process confirmed that recurring risk factors across school precincts could be systematically identified through a structured diagnostic approach and addressed by activating combinations of the framework's six integrated pillars: education and awareness; engineering and the built environment; enforcement and compliance; encouragement and active travel; engagement and collaboration; and evaluation and learning, while retaining flexibility for local context. The final Guide integrates problem-based modules aligned to behavioural, environmental, and infrastructure-related risks and delivers these through an Intensive, Selective, and Universal model. This structure enables proportionate responses across diverse school settings and provides a consistent basis for decision-making where resources are limited. The completed Guide represents the primary outcome of this work and offers a practical, evidence-informed framework to support safer school precinct planning and delivery.

Benefits to road safety

The finalised Guide supports more consistent and evidence-informed planning for school precinct safety by providing a structured framework to identify and prioritise locally relevant risks. By aligning behavioural, environmental, and infrastructure-related considerations within a single diagnostic process, the approach assists councils and partner agencies to move beyond fragmented or ad-hoc responses. The tiered delivery model supports proportionate decision-making, helping ensure that available resources are directed to schools and risks where they are most needed, with the potential to reduce exposure to high-risk conditions and strengthen the safety of school travel environments for children.

Implications for policy and/or practice

The Guide provides policymakers and practitioners with a practical, transferable framework to support more consistent school precinct safety decision-making. Its structured diagnostic approach and tiered delivery model offer a defensible basis for prioritisation, supporting transparency, equity, and alignment across agencies. Adoption of the framework can assist councils to embed evidence-informed practice into routine planning and program delivery, reduce variability in local approaches, and strengthen governance of school precinct safety initiatives. By embedding education, engineering, enforcement, engagement, encouragement, and evaluation within a single diagnostic and delivery framework, the Guide supports coordinated, whole-of-system responses to high-risk conditions and contributes to efforts to reduce road trauma involving children.

Conclusions

This work resulted in the development of A Practical Guide to Safer School Precincts, a consolidated framework and tiered delivery model translating local evidence and Monitoring, Evaluation and Learning (MEL) insights into a structured, transferable approach for school precinct safety planning. The Guide integrates six interconnected pillars; education and awareness, engineering and the built environment, enforcement and compliance, encouragement and active travel, engagement and collaboration, and evaluation and learning, within a single diagnostic and delivery framework. By systematically identifying locally relevant risks and activating proportionate combinations of these pillars through problem-based modules and a tiered delivery model, the Guide supports consistent, evidence-informed decision-making across diverse school contexts. The primary contribution of this work is a practical, scalable approach that strengthens coordination, reduces variability in local responses, and enables councils and partner agencies to manage school precinct risks more systematically, supported by national dissemination of the Guide to Australian councils. Next steps focus on embedding the MEL framework into routine program planning and delivery, strengthening prioritisation and sequencing of interventions, and assessing national uptake and adaptation of the Guide over time.

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Incorporating procedural justice into random breath testing: effects on speeding

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Abstract
Previous research has suggested that benefits result from incorporating procedural justice into road policing initiatives. This study evaluated the incorporation of procedural justice into random breath tests at a known high-risk road to identify if there was a reduction in the travelling speeds of drivers and riders after the interaction. A randomised control trial was conducted with three conditions: (a) procedurally just random breath test (b) standard random breath test and (c) no interaction with police. Average travelling speed was measured using three discreet wildlife cameras placed at locations following the interaction. Analysis of 2,485 trips identified that drivers and riders in the procedural justice condition travelled more slowly for at least 3.6 kilometres post-interaction than those in the other two conditions. This suggests that the use of procedural justice in roadside interactions between police and drivers and riders can change subsequent behaviour.

Introduction
Procedural justice is predicated on officers treating the public fairly, respectfully, and transparently during interactions, with the potential to improve public trust and cooperation with police. The procedural justice framework is grounded in four key principles: neutrality in decision-making, giving citizens a voice in proceedings, treating people with respect, and demonstrating trustworthiness through genuine concern (Madon et al., 2023; Mazerolle et al., 2013). In a road policing context, research has previously demonstrated that the inclusion of procedural justice within road safety initiatives can change perceptions of drink driving (Mazerolle et al., 2012); reduce subsequent speeding offences for those 25 years and older (Bates et al., 2025) and improve perceptions of police (Sahin et al., 2024). While other studies have suggested the impact of procedural justice in road policing may be less effective (MacQueen & Bradford, 2015; Op de Weegh et al., 2026), this may be related to other issues such as implementation (MacQueen & Bradford, 2017; Op de Weegh et al., 2026).

The aim of this project was to incorporate the principles of procedural justice into a roadside interaction, a random breath test (RBT), with drivers and riders in order to change behaviour in a known high-risk area. In Queensland, police officers have the authority to require any driver and rider to stop their vehicle for the purposes of conducting a test even if there is no suspicion of alcohol or drug consumption. This provides an opportunity for police officers to interact with drivers and riders in a manner that may affect their future driving or riding.

Conference theme
This paper address the ARSC2026 theme *From Evidence to Action: Shaping a Brighter Future* by reporting on a collaborative project between researchers and police. The project trialled and evaluated an intervention to reduce crashes and speeding behaviour on a road that was known to have high crash rates. We used existing empirical evidence to develop an intervention (*the evidence*), working with a policing agency to implement an intervention and then evaluate using a randomised control trial (*to action*).

Method
This study used a randomised control trial with three conditions (1) an experimental condition which involved random breath test interactions incorporating the principles of procedural justice (2) a standard (business-as-usual) RBT interaction and (3) no intervention. RBTs were conducted on Saturday and Sunday mornings. Table 1 provides an overview of the experimental conditions.

At least one member of the research team was on site for each operation to record licence plates and approximate stop time for intercepted vehicles. Cameras were placed at three points on the road leading away from the RBT location in order to calculate average speed between the three points. The cameras used were small and discrete to minimise any potential behaviour change due to road users believing they were under observation. The first camera site was approximately 700 metres from the RBT site allowing motorcycle riders travelling together an opportunity to regroup

after being breath tested. The total distance from camera 1 to camera 3 was 3.6km. Camera 1 to camera 2 was 1.7km and camera 2 to camera 3 was 1.9km.

Table 1. Overview of experimental conditions

Condition 1 **Procedurally Just RBT** **(police intervention)** **n = 6**	**Condition 2** **Standard RBT** **(police intervention)** **n = 7**	**Condition 3** **Control** **(no police)** **n = 5**
Officers conducted RBTs using a PJ script emphasising fairness and respect. Officers handed survey AND educational flyer to drivers and riders.	Officers performed standard RBT operations without a script AND handed survey to drivers and riders.	No direct police interaction with drivers and riders.
Registration details recorded by researchers at intercept site and matched to rego from speed monitoring cameras.	Registration details recorded by researchers at intercept site and matched to rego from speed monitoring cameras.	Registration details recorded on survey and matched to rego from speed monitoring cameras.

Automatic Number Plate Recognition technology and research assistants matched licence plates identified by the cameras at the three points of observation with those who interacted with police officers on either the procedurally just or standard RBT days. This was used to calculate the dependent variable: average travelling speed.

The original data file contained 4,231 instances of drivers and riders travelling on the road. However, the number of cases was reduced to 3,245 (986 cases removed) to ensure that only drivers and riders who could be linked across all three camera sites were included. A further 692 cases (21.3%) were removed as they had not interacted with police officers during an RBT operation on a day when either a standard or procedurally just RBT operation was occurring. This left 2,553 cases remaining. For the purposes of addressing outliers, the interquartile range method was used for identification and removal. Using this method, 68 cases or 2.66 percent of the 2,553 cases were removed from the subsequent analyses. A total of 2,485 driver and rider trips were included in the analysis.

Results

Three one-way ANOVAs identified if there were significant differences between driver and rider travelling speeds between the three conditions. All three models were significant, suggesting differences between at least two conditions in each test (see Table 2).

Table 2. Average travelling speed (kmph) across the three research conditions

	Total distance: 3.6km		**Part 1: 1.7km**		**Part 2: 1.9km**	
	Point 1 to 3		**Point 1 to 2**		**Point 2 to 3**	
Operational Type	**M**	**SD**	**M**	**SD**	**M**	**SD**
Standard RBT	55.05	7.81	55.84	8.34	59.54	9.06
Procedural just RBT	52.55	7.89	54.44	8.27	56.92	10.04
No police intervention	55.08	7.69	56.74	8.35	60.19	9.22
Test Statistics	$F(2,2482)= 19.87$, $p < .001$; $\eta 2=.016$		$F(2,2482)= 13.52$, $p < .001$; $\eta 2=.011$		$F(2,2482)= 21.22$, $p < .001$; $\eta 2=.017$	

Figure 1 shows that for the total distance of observation and both smaller components of the trip, the average speed of travel was visibly lower for those in the procedural justice intervention condition than both other conditions.

To examine which conditions were statistically different, multiple comparisons were made using the Tukey HSD test. This test revealed that the average travelling speed of those in the procedural justice intervention condition was significantly lower than both the business-as-usual intervention and control condition speeds.
No statistically significant differences were found between the business-as-usual and control conditions in any of the three tests. However, the difference between the business-as-usual and control condition did approach significance for the distance between point 1 to point 2 (mean difference = 0.90 kmph, $p = .059$).

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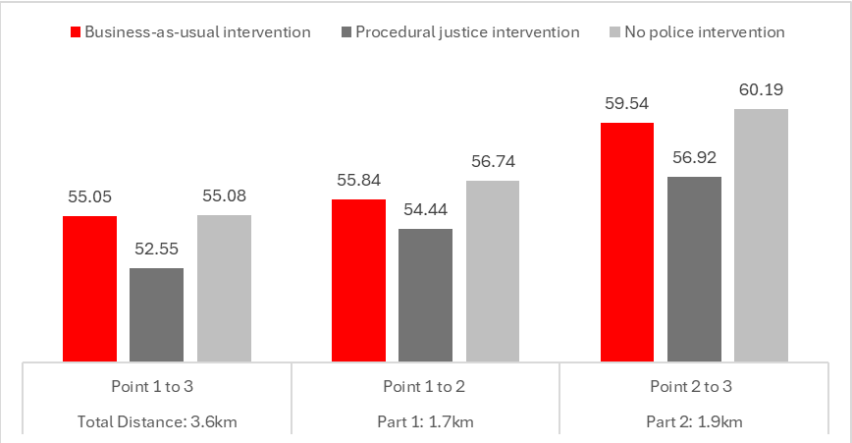

Figure 1. Average travelling speed (kmph) across the three conditions

Benefits to road safety

Speeding is associated with both more frequent and more severe crashes (Elvik, 2005; Job & Brodie, 2022). This study has found that the introduction of a countermeasure targeted at a known high-risk road can reduce the speeds at which drivers and riders travel.

Implications for policy and/or practice

Given the findings from this experiment, all frontline police officers undertaking traffic enforcement should be trained on using the principles of procedural justice within their interactions. While this study has shown that RBT operations can be used as a tool to change other offending behaviour on the road (in this case speeding), care should be taken that the primary purpose of the RBT interaction remains – reducing impaired driving on the road.

Conclusions

This study used a randomised control trial to test whether including the principles of procedural justice in an RBT reduces the travelling speeds of drivers and riders. Drivers and riders who participated in a procedurally just RBT with police officers travelled more slowly after the interaction when compared with those who received either the standard RBT or had no interaction. This provides evidence that supports the use of procedural justice in roadside interactions between police officers and the public to improve road safety outcomes.

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Tasmania's Road Safety Enforcement Allocation Model

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Abstract
This paper presents the Road Safety Enforcement Allocation Model (RSEAM), a framework collaboratively developed by the Department of State Growth and Tasmania Police to inform the allocation of enforcement activity in Tasmania, Australia. RSEAM integrates a targeted review of international and Australian enforcement literature, best-practice, and quantitative enforcement modelling underpinned by economic analysis. The model assesses the effectiveness of multiple enforcement modes, using a mixture of manual and automated enforcement. Using crash, speed and enforcement data, the RSEAM estimates changes in trauma across future enforcement scenarios and evaluates the benefit-cost ratio of each scenario. The model demonstrated that substantial reductions in road trauma could be achieved through a balanced mix of general and specific deterrence, with both site-specific and network wide impacts. All modelled scenarios demonstrated strong economic outcomes. The RSEAM provides an evidence-based framework to support policy development, enforcement activity planning, and investment prioritisation within a Safe System context.

Introduction
The Road Safety Enforcement Allocation Model (RSEAM) was developed for the Department of State Growth Tasmania (DSGT) to support delivery of the Towards Zero Tasmanian Road Safety Strategy 2017–2026, which targets a goal of fewer than 200 fatal and serious injuries (FSIs) per year by 2026. The Strategy is underpinned by the Safe System approach with enforcement identified as a critical lever to influence road user behaviour and reduce trauma. The RSEAM provides an evidence-based framework to guide the allocation of existing enforcement resources, inform future investment decisions and support best-practice enforcement operations. The model integrates international and Australian research, Tasmanian data, stakeholder input, economic analysis and scenario testing.

The five key outputs of the RSEAM project were:

- a targeted literature review of current and emerging enforcement modes
- best-practice deployment guidance
- selection and prioritisation of candidate corridors/sites for each mode of enforcement
- an enforcement allocation and optimisation model underpinned by cost–benefit analysis
- an interactive scenario-testing dashboard.

Conference theme
This project embodies the conference theme *From Evidence to Action: Shaping a Brighter Future* by translating a substantial body of road safety research into a practical, decision-support tool for policy and operational use. The RSEAM moves beyond identifying 'what works' by embedding international and Australian evidence into a quantitative framework, actively guiding enforcement planning, investment prioritisation and program design.

The evidence from literature, local crash and speed data, and economic analyses was examined through scenario modelling and an interactive dashboard – enabling DSGT and Tasmania Police (TasPol) to test, compare, and refine enforcement strategies before implementation. This supports transparent, evidence-based decision-making and reduces reliance on intuition or historical practice alone. By linking enforcement activity directly to measurable reductions in fatal and serious injuries, the RSEAM provides a clear pathway from analysis to implementation. In doing so, the project demonstrates how evidence-based tools can drive tangible action, improve safety outcomes and support a sustainable, system-wide approach to reducing road trauma.

Project Description
The technical outputs of this project support strategic road safety enforcement decision-making in Tasmania. The outputs were a comprehensive literature review, best-practice enforcement deployment guidance, spatially mapped candidate locations and priorities for each enforcement mode, an enforcement allocation and optimisation model with economic analysis and an interactive scenario-testing dashboard.

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Literature review

A targeted literature review examined the effectiveness of different enforcement modes relevant to the Tasmanian context. The enforcement modes reviewed included manual police intercept, automated speed enforcement (spot and average speed, mobile and fixed), red-light and speed-red-light cameras, random breath testing (RBT), random drug testing (RDT), seatbelt use and mobile phone/distraction (mobile and fixed). Emerging technologies such as in-motion or roaming enforcement and mobile average cameras were also reviewed. The literature review also identified best practice for implementing each mode of enforcement.

Key findings from the literature review included:

- Speed enforcement is highly effective, particularly automated enforcement. Spot speed cameras reduce casualty crashes by around 20% (Høye, 2014), while average speed cameras deliver larger and more sustained reductions, especially for fatal and serious crashes.
- Mobile speed cameras support both general and specific deterrence when operations are unpredictable and not signposted. Warning signage undermines their effectiveness (Cameron & Delaney, 2006).
- Red-light and speed-red-light cameras significantly reduce right-angle and injury crashes at intersections, with an overall positive net safety effect despite some increase in low-severity rear-end crashes (Goldenbeld et al., 2019).
- RBT is most effective when highly visible, widespread and perceived as unavoidable, delivering broad general deterrence (Ferris et al., 2015).
- The body of evidence on the effectiveness of RDT is small but the evidence available suggests a combination of general and specific deterrence is required, with effectiveness varying by drug type.
- Mobile phone and seatbelt cameras show strong compliance effects and substantial modelled safety benefits, particularly when covertly operated and widely deployed (Stephan & Allen, 2021).

Best-practice deployment guidance

A best-practice guide to support operational planning and delivery of enforcement was also developed. This guidance synthesises research evidence and stakeholder input from the Department of State Growth, Tasmania Police, road safety experts and technology providers. The guidance was designed to help agencies review current practice, improve consistency with evidence-based principles, and plan future enforcement programs that maximise deterrence and public trust.

The best practice guide addresses:

- appropriate visibility (overt vs covert) for each enforcement mode
- site and corridor selection and prioritisation principles
- recommended enforcement duration and visitation frequency
- occupational health and safety considerations
- technology limitations and operational constraints.

Candidate Corridors/ Locations

Using spatial data analysis techniques, candidate enforcement locations for each enforcement mode were mapped to understand potential safety benefits. Candidate corridors and sites were prioritised based on their expected reductions in FSI crashes, with benefit-cost ratios used to exclude locations with poor value for money. Mobile enforcement focuses on rotating deployments to maximise network deterrence, while fixed and average speed cameras are ranked by FSI reduction and assessed at a program level to account for site suitability and overlap with other safety initiatives.

Enforcement modelling approach

The model quantifies the safety and economic impacts of different enforcement mixes. It uses Tasmanian-specific data, including: crash data (2019–2023); speed and traffic volume data; existing enforcement activity and operating costs and social costs of crashes, from the Australian Transport Assessment and Planning (ATAP) Guidelines.

Different modelling techniques were applied depending on the enforcement mode:

- elasticity-based models (e.g. RBT, highway patrol)
- intensity-based models (e.g. mobile speed cameras)
- coverage-based models (e.g. mobile phone cameras)
- site-based local effects (e.g. fixed cameras).

Crash reductions from multiple modes were combined multiplicatively to reflect compounding deterrence effects. The economic analysis estimated enforcement costs, crash cost savings and BCRs.

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Scenario development and results

Five primary scenarios were developed targeting a 10–30% reduction in FSI crashes, plus a sixth scenario targeting a 30% reduction across the whole Tasmanian network. Scenarios were designed to balance:

- network and local effect
- overt and covert enforcement
- cost-effectiveness (all scenarios achieve BCRs greater than 10)
- realistic increases from current enforcement activity levels (within 100% increase).

The key findings from the scenario development were:

- A 30% statewide trauma reduction equates to approximately 73 fewer FSI crashes per year, delivering around $146 million per annum in social cost savings.
- Annual enforcement costs for this scenario are modest relative to benefits, resulting in a BCR of approximately 10.7.
- The most effective enforcement mix relies heavily on mobile speed enforcement (overt and covert), supported by RBT, RDT, highway patrol, fixed cameras and automated mobile phone/seatbelt enforcement.

Interactive Dashboard

A Power BI dashboard was developed to present optimised enforcement and FSI target scenarios, removing infeasible sites and to compare safety and economic outcomes. The dashboard was configured to enable flexible decision making and planning to address changes in available aggregate investment profiles and/or specific investment in an enforcement mode – supporting iterative program development.

Benefits to road safety

This work provides Tasmania with a structured and transparent means of translating road safety evidence into practical enforcement decisions. By integrating international and Australian research with Tasmanian crash, speed, traffic, enforcement and cost data, the RSEAM ensures that enforcement strategies are grounded in evidence and best practice, not historical practice or intuition.

Implications for policy and/or practice

The RSEAM helps prioritise where and how DSGT resources are deployed by identifying the enforcement modes, and application that deliver the greatest safety benefit. This improves efficiency and avoids dispersing effort across low-impact activities. The RSEAM directly links enforcement effort to expected reductions in fatal and serious injury (FSI) crashes. Scenario testing demonstrates that substantial reductions in trauma can be achieved through realistic changes to enforcement mix and intensity. While enforcement alone cannot achieve Towards Zero, this work strengthens the safer road users pillar of the Safe System. By embedding continuous learning, evidence review and scenario testing, the RSEAM supports sustained reductions in road trauma and safer roads for Tasmanian road users.

Conclusions

The Road Safety Enforcement Allocation Model provides Tasmania with a robust, evidence-based framework for translating road safety research into practical enforcement action. By integrating local data, international evidence and economic analysis, the project demonstrates how targeted and well-balanced enforcement programs can deliver substantial reductions in fatal and serious injuries while achieving strong value for money. While enforcement alone cannot achieve Towards Zero, the RSEAM strengthens Tasmania's ability to prioritise investment, deploy resources effectively and make transparent, defensible decisions. A living decision-support tool, the RSEAM also creates a foundation for continuous improvement, enabling enforcement strategies to evolve alongside emerging evidence, technologies and community expectations.

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High performance vehicle restrictions – when technology outpaces policy

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Abstract
High-performance vehicle (HPV) restrictions were introduced to reduce crash risk among novice drivers, traditionally relying on power-to-weight thresholds and engine modification criteria as proxies for risk. However, rapid changes in vehicle technology and patterns of vehicle ownership, particularly the widespread adoption of advanced safety systems and the growth of electric vehicles, have weakened the validity of these measures. This work reviews current literature and examines changes in vehicle technology and the passenger fleet to assess whether existing restrictions continue to achieve their intended safety outcomes. The findings highlight opportunities to modernise novice-driver vehicle policy by shifting from performance-based exclusions toward risk-based criteria that better reflect contemporary vehicle fleet profile.

Background
High performance vehicle restrictions for novice drivers were introduced in several Australian jurisdictions to reduce crash risk among inexperienced drivers. These restrictions traditionally target vehicles with a high power-to-mass ratio or engine modifications, based on early evidence linking vehicle performance to higher crash severity (Colquhoun 2007).

However, novice driver crash risk has long been influenced by factors beyond vehicle performance alone. Earlier analyses, including by Whelan et al. (2009) and Watson & Newstead (2009), demonstrated that young drivers are more likely to drive older vehicles, are over-represented in crash types such as single-vehicle, run-off-road and head-on crashes, and that these patterns are strongly influenced by the types of vehicles they drive. These studies showed that novice drivers frequently select older vehicles with lower levels of crash protection, meaning their risk of being involved in a fatal or serious injury crash is compounded by vehicle factors beyond engine performance alone.

Since the release of that work, the automotive landscape has continued to evolve, and the limitations of performance-based restriction criteria have become more pronounced. Modern vehicle technologies play a critical role in mitigating both crash likelihood and injury severity. The emergence of electric vehicles have further disrupted the relationship between acceleration capability and real-world risk by expanding the availability of vehicles with high acceleration rates as family vehicles that also feature advanced safety systems. This shift has weakened the justification of power-to-weight thresholds as a proxy for crash risk and has amplified the importance of safety-performance characteristics that are not reflected in current restrictions.

The combined evidence highlights a growing mismatch between regulatory settings and contemporary vehicle risk characteristics. Novice drivers continue to experience elevated crash involvement, but the evidence increasingly shows that their risk is more strongly shaped by behavioural factors and the safety profile of the vehicle they drive than by raw performance capability. With emerging vehicle technologies, an opportunity has emerged to re-evaluate existing vehicle restrictions and explore alternative, evidence-based approaches that better reflect and novice driver risk and vehicle safety performance.

Conference theme
This study uses contemporary evidence to challenge long-standing policy surrounding high-performance vehicle restrictions. The analysis highlights how changes in vehicle technology have outpaced traditional regulatory approaches, creating an opportunity for evidence-informed policy reform.

By identifying unintended consequences of current restrictions and proposing modern, risk-based alternatives, the study transforms empirical insights into practical actions that can reduce trauma among young drivers. This aligns with the conference's call to rethink what must be done differently and ensure that emerging evidence actively shapes future road safety strategies.

Method
We synthesised published crash analyses, vehicle safety evaluations, and fleet data across Australian jurisdictions, to examine the alignment of current policy with recent advancements in vehicle technology.

Results

Novice driver crash factors

Novice drivers remain disproportionately represented in high-severity crashes due to a combination of behavioural, exposure-related, and vehicle-related factors. Limited driving experience contributes to delayed hazard perception, poor speed selection, and difficulties in maintaining lane position, which increase the likelihood of single-vehicle, run-off-road, and head-on crashes (Guthrie 2024).

These patterns have been consistently identified in earlier research, including MUARC's analysis of young driver crash types (Whelan et al. 2009), which highlighted the role of vehicle choice and behavioural factors:

- **Vehicle choice:** Young drivers frequently drive older vehicles lacking critical safety technologies such as electronic stability control, advanced restraint systems, and optimised structural protection. The disparity in vehicle safety performance compounds the inherent crash risk associated with inexperience, leading to greater injury severity in the event of a collision.
- **Behavioural factors:** Young drivers often exhibit higher levels of risk-taking, including overconfident driving, distraction, and driving at night.

These factors highlight the importance of aligning novice driver vehicle access with evidence-based safety principles and ensuring regulatory settings reflect the realities of young driver risk profiles.

Advancements in safety technology

Recent evidence, including the VSRG research report by Budd *et al.* (2021), shows that novice drivers gain particularly strong safety benefits from vehicles equipped with modern driver assistance technologies. Features such as electronic stability control, autonomous emergency braking, lane support systems, and speed assistance functions are associated with significant reductions in crash involvement for young drivers. The study found that 14% of young driver injury crashes could be avoided if young drivers were mandated to use this technology, an impact 75% higher than if the requirement was imposed on experienced drivers. No evaluation of the impact of current restrictions has been published, preventing the ability to provide a direct comparison.

The findings of this analysis highlight the growing mismatch between current restrictions and the protective capability provided by advanced safety systems. Incorporating technology based criteria into novice driver vehicle restrictions would more accurately reflect real risk exposure and allow regulatory settings to take advantage of the measurable safety benefits associated with contemporary vehicle technologies.

Implications for Electric Vehicle uptake

There has been a rapid and growing uptake in electric vehicles in recent years (DITRDCA, 2024). These vehicles typically offer advanced safety technology to help avoid a crash or mitigate the severity of the outcome. However, novice drivers are often restricted from driving EVs due to existing high-performance vehicle rules, which classify many as prohibited. As a result, young drivers may not be permitted to access the safest vehicle in the household, despite it being the car with the greatest overall crash-avoidance and crash-protection capability.

To illustrate the policy implications, the safest vehicle of 2025, as rated by ANCAP, was the Tesla Model Y (ANCAP, 2026), however of the twelve variants available, only one is listed as permitted for novice drivers in NSW (TfNSW, 2026). This is despite the vehicle allowing for parental controls that can limit vehicle acceleration rate and provide other oversight features. In contrast, a random sampling of 1-star vehicles as rated by the Used Car Safety Ratings are all permitted for novice drivers (Rampollard et al. 2025; TfNSW, 2026).

As a result, families may provide novice drivers with am inexpensive vehicle that meets performance restrictions, but which may be significantly older, have fewer integrated safety technologies, and offer lower levels of structural and restraint-system protection, thereby increasing exposure to high-severity crash outcomes. Evidence from the DRIVE study (Chen *et al.*, 2024) adds another concern, showing that young drivers with access to their own vehicle have a 30% higher crash risk compared to those who primarily drive a family vehicle, and 15 times higher FSI crash risk.

Benefits to road safety

This study supports enhanced road safety by identifying limitations in existing high-performance vehicle restrictions and demonstrating how they can be modernised using contemporary evidence. By quantifying the safety gap created when novice drivers are diverted into older, lower-rated vehicles, the work highlights a measurable regulatory

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inefficiency. Incorporating risk-based criteria that account for safety technologies—such as ESC, AEB, and vehicle performance management systems—can more accurately target high-risk scenarios and reduce crash severity among novice drivers.

Findings also show that aligning restrictions with modern vehicle capabilities enables improved fleet safety composition for young drivers, reducing system-wide exposure to high-risk vehicle types. A transition to evidence-driven regulatory settings therefore provide a clearer mechanism for reducing trauma through improved vehicle selection, better risk discrimination, and opportunities for integrating behavioural-monitoring technologies.

Implications for policy and/or practice

Performance-based vehicle restrictions should be re-evaluated. Policy changes to encourage younger drivers into cars with modern safety features should be explored including:

- Shift from blanket power-to-weight limits to risk-based criteria incorporating safety technology.
- Changes to vehicle restrictions for novice drivers, that may be based on some minimal vehicle safety features or vehicle performance in the Used Car Safety Rating program.
- Use of parental controls and telematics-based monitoring to allow young drivers to use HPVs in low performance mode. These changes could enable supervised or conditional access to safer family EVs.

Conclusions

This review demonstrates that traditional performance-based novice-driver vehicle restrictions no longer align with changes in vehicle technology. Evidence shows that current criteria can inadvertently increase exposure to harm by diverting young drivers into older, lower-rated vehicles, while failing to leverage advances in safety technology and vehicle performance management. In light of advances in vehicle safety technology and the increasing uptake of electric vehicles, there is a timely opportunity to adopt a more nuanced approach to novice driver vehicle policy.

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Joey Crossings - cheaper, easier, still Primary Safe System

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Abstract
At-grade zebra crossings rely heavily on driver compliance and do not inherently manage vehicle approach speeds, resulting in variable safety performance. Raised platform crossings provide strong Safe System alignment and substantial reductions in pedestrian casualty crashes, but cost, drainage and constructability constraints can limit their feasibility. This project investigates a lower cost alternative, termed the Joey Crossing (a baby wombat), which applies speed cushions on the approach to zebra crossings to moderate vehicle speeds. The study developed structured design guidance, identified risk considerations and established an evaluation framework aligned with Safe System principles. Findings indicate that approach speed management through cushions may improve yielding behaviour and reduce crash likelihood and severity. The treatment offers a scalable, pragmatic option to enhance pedestrian safety where full platform crossings are not feasible.

Background
At-grade pedestrian crossings, commonly referred to as zebra crossings, leave open the potential for high-speed vehicle impacts. International research shows wide variation in reported Crash Reduction Factors and Crash Modification Factors for these facilities, ranging from reductions in pedestrian safety (Zegeer et al., 2001) through to only modest safety improvements (Elvik et al., 2009). This variability reflects the fact that zebra crossings rely heavily on driver compliance and do not inherently manage approach speeds.

In contrast, raised pedestrian crossings are consistently associated with substantial safety benefits. Makwasha and Turner (2015) report a 73 percent reduction in total pedestrian casualty crashes following installation of a raised crossing, commonly known in Australia as a Wombat Crossing. By physically moderating vehicle speeds at the conflict point, raised platforms align more closely with Safe System principles and human tolerance to crash forces.

Despite their effectiveness, Wombat Crossings are often high-cost interventions. Civil works, drainage modifications, lighting requirements and grade constraints can significantly increase implementation costs. In some locations, particularly where drainage design is complex, installation may not be feasible.

The City of Greater Geelong is therefore exploring whether a lower cost, simpler treatment can retain the primary Safe System benefits of raised crossings while overcoming key constructability and budget barriers.

Conference theme
A lower cost pedestrian crossing that remains strongly aligned with Safe System principles, and grounded in evidence, has the potential to accelerate delivery at scale. More crossings delivered. Safer movements achieved. Greater equity in access. More meaningful safety action on the ground.

Project description
Across Australia and New Zealand, several jurisdictions have introduced traffic calming measures on the approach to pedestrian crossings. Below are examples from Queensland, NSW and Victoria, (see Figures 1-4).

These treatments vary in form and application, including speed cushions, platforms and other vertical deflection devices. While individual sites have been implemented and observed, there has been limited consolidation of design guidance, risk considerations and documented performance outcomes.

For this project, a decision was made to formalise and name the treatment as a Joey Crossing – a baby wombat.

This project addressed a knowledge gap by providing structured design guidance, risk analysis and an evaluation framework to support informed decision making.

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It comprised two components.

Component A developed treatment design and application guidance. This included identifying suitable road contexts, understanding when a raised platform such as a Wombat Crossing may not be appropriate, and evaluating risks such as motorcycle and bicycle stability, heavy vehicle dynamics, maintenance implications and vertical geometry. Practical guidance was prepared covering materials, signage, linemarking and layout options, supported by concept drawings.

Component B established an Evaluation Framework to objectively assess Joey Crossings. This involved a workshop with the City of Greater Geelong, a literature and practice review, and engagement with other jurisdictions to understand outcomes and lessons learned. The framework defined the problem, aligned objectives with Safe System principles, identified quantitative and qualitative measures, and set out a structured approach to assessing performance over time.

The final output was a consolidated report outlining findings, design guidance and the evaluation framework.

Figure 1. Joey Crossing in Queensland
Source: Prue Oswin (reproduced with permission)

Figure 2. Joey Crossing in NSW

Figure 3. Joey Crossing in Victoria (1)

Figure 4. Joey Crossing in Victoria (2)

Findings

Traditional zebra crossings rely heavily on driver vigilance and compliance. In environments above 30 km/h this dependence on behaviour is inconsistent with Safe System principles, as impact speeds may exceed human tolerance.

Raised zebra crossings are effective because they physically reduce speeds to around 30 km/h and strongly align with Safe System objectives. However, they can present drainage challenges, DDA constraints, noise impacts, comfort issues for cyclists and heavy vehicles, diversion risks, and higher construction costs.

Speed cushions offer a lower cost alternative form of vertical deflection. They can reduce operating speeds with minimal drainage impact, limited effects on cyclists, and fewer implications for buses, heavy vehicles and kerb ramp tie-ins. When appropriately designed, they are likely to reduce 85th percentile speeds, improve yielding behaviour, and lower crash likelihood and severity.

Design and placement are critical. Key considerations include upstream positioning, paired installation to prevent bypassing, removal of adjacent parking, appropriate advisory speeds, adequate sight distance and lighting, and durable material selection.
Overall, speed cushions represent a pragmatic intervention to better align zebra crossings with Safe System principles, provided careful site selection, detailed design and formal evaluation are undertaken.

Benefits to road safety
This will enable more crossings to be made safer and assist local governments to have the confidence to install this low-cost solution.

Implications for policy and/or practice
This work enables infrastructure and active transport programs to deliver more outcomes with the same resources, while strengthening alignment with Safe System principles. It supports action at sites that might otherwise be dismissed as too complex or too difficult to treat.

Conclusions
Zebra crossings play an important role in supporting walkability and equitable access. However, when installed in speed environments above 30 km/h without physical speed management, they rely heavily on driver vigilance and compliance. This dependence is inconsistent with Safe System principles, which recognise both human vulnerability and the inevitability of error.

Raised platform crossings provide strong alignment with Safe System objectives by physically moderating speeds at the point of conflict. Yet cost, drainage complexity, constructability constraints and community impacts can limit their feasibility at many sites.

The Joey Crossing concept responds directly to this implementation gap. By introducing managed approach geometry through speed cushions, it seeks to moderate vehicle speeds upstream of the crossing point without many of the disadvantages associated with full width platforms. When carefully designed, located and evaluated, this treatment has the potential to meaningfully reduce approach speeds, improve yielding behaviour and lower both crash likelihood and severity.

Importantly, this work demonstrates that Safe System alignment is not only about selecting the ideal treatment in theory, but about enabling practical, scalable action in the real world. A lower cost, evidence informed intervention such as the Joey Crossing can expand the number of sites where speed management is delivered, supporting more equitable access and safer pedestrian movements across the network.

A structured trial and evaluation will be essential to confirm performance in the local context. However, the findings indicate that this treatment represents a credible, pragmatic pathway to accelerate safety improvements at zebra crossings that might otherwise remain untreated.

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Why speed evidence fails to shift policy

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Abstract
Strong scientific evidence confirms that lower speeds reduce crash likelihood and injury severity. Yet speed limit reductions, particularly on high-speed rural roads, often face public resistance. This paper integrates road safety science with risk perception theory to explain this divergence. Drawing on Nilsson's Power Model, Safe System principles, and Sandman's risk plus outrage framework, a structured mapping method is developed to align objective crash risk with qualitative perception factors such as control, voluntariness, familiarity, and vulnerability. By bridging risk and outrage, the framework provides a practical pathway for translating speed evidence into durable policy action, strengthening implementation and accelerating reductions in death and serious injury.

Background
Speed management is one of the most effective interventions for reducing death and serious injury. The relationship between speed and trauma is theoretically and empirically robust. Nilsson's Power Model shows that small increases in mean speed produce disproportionate increases in fatal and serious injury outcomes (Nilsson, 2004), a finding consistently supported in synthesis research (Elvik et al., 2019). Within a Safe System framework, speed limits are core system design parameters aligned with human tolerance to physical force (Strandroth et al. 2024).

Despite this evidence, speed limit reductions often face resistance, particularly on high-speed rural roads with high trauma rates. Risk perception research helps explain this gap. Public judgements are shaped not only by statistical risk but by factors such as perceived control, voluntariness, and familiarity (Slovic, 1987). Integrating crash science with risk perception theory provides a stronger foundation for sustainable speed reform.

Conference theme
This paper aligns with the ARSC2026 theme by examining why strong speed evidence does not always translate into policy action. By integrating crash science with risk perception theory, it focuses on how evidence can be more effectively operationalised, bridging the gap between knowledge and implementation to support durable Safe System speed reforms.

Method

Study Design
This study adopts a structured conceptual mapping approach to translate Sandman's risk perception framework into the speed management and road safety context. Sandman's "risk plus outrage" model proposes that public judgement of risk is not determined solely by technical risk (the objective probability and severity of harm) but by a combination of theoretical risk and emotional and social responses to risk, which he collectively terms "outrage" (Sandman, 1993). This model has been widely applied in environmental and public health domains to explain why communities respond differently to risks with similar technical profiles.

Theoretical Framework
The analytical foundation combines Sandman's risk plus outrage model with core constructs from the psychometric paradigm of risk perception. In road safety, risk is defined as the product of crash likelihood and injury consequence, informed by biomechanical tolerances and the well documented relationship between speed and trauma severity (Nilsson, 2004; Elvik et al., 2019). Outrage encompasses qualitative attributes known to shape public perceptions, including perceived control, voluntariness, fairness, familiarity, and moral judgement (Sandman, 1993; Slovic, 1987). Driving and travel behaviour are often highly familiar and perceived as controllable, conditions that literature shows reduce perceived risk even when statistical risk is high.

Development of the Mapping Matrix
A three-stage process was undertaken to develop the analytical matrix that maps outrage factors to speed limit and road safety contexts across road environments.

Stage 1: Identification of Outrage Dimensions
Key outrage dimensions were identified from Sandman's model and cross referenced with attributes from the psychometric risk perception literature. Overlapping constructs were consolidated to avoid conceptual redundancy.

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Stage 2: Definition of Speed Context Variables
Speed limit environments were categorised into analytically distinct contexts such as high-speed rural roads, peri urban arterials, urban activity centres and school zones. For each context, risk was characterised using established road safety variables including exposure, infrastructure protection level, road and roadside severity, separation and known crash typologies.

Stage 3: Construct Mapping
Each identified outrage dimension was systematically mapped against the defined speed limit contexts using a structured coding logic. For each pairing, the following were assessed: Whether the outrage factor is inherently activated by the road environment or proposed speed change, whether the factor is amplified or attenuated by system design features, the likely direction of influence on public support for speed reduction.

This mapping was guided by theoretical definitions supported by empirical findings from speed attitude research and risk perception studies. The resulting matrix produces a context specific profile of risk and anticipated perception driven responses, which can be used to inform policy design and communication strategy in speed management reform.

Findings
Application of the risk plus outrage mapping framework across defined speed environments revealed consistent and theoretically coherent patterns in the relationship between objective crash risk and anticipated public response.

High Risk, Low Outrage: High Speed Rural Roads
High speed rural roads were characterised by elevated objective risk due to high travel speeds, limited median separation, unforgiving roadsides, and high severity crash types. In biomechanical and epidemiological terms, these environments sit furthest from Safe System tolerances.

As a high speed rural road operating at the default 100 km/h limit, outrage factors were generally attenuated in this context (that is, there was limited public pressure for change). Driving in rural environments is highly familiar and strongly associated with perceived personal control. Speed choice is viewed as voluntary, and the perceived benefits of higher speeds, particularly travel time savings and mobility efficiency, are salient at the individual level. Harm is also diffused across time and geography, which reduces memorability and the perceived immediacy of risk. However, when speed limit reductions were proposed on these roads, the opposite response emerged and public outrage increased, reflecting the inverse influence of these same outrage factors.

The mapping therefore consistently placed high speed rural roads in a high risk, low outrage quadrant. This alignment provides a structured explanation for recurrent resistance to rural speed limit reductions despite strong empirical evidence of trauma reduction benefits.

Medium Risk, High Outrage: School and Vulnerable User Contexts
In school zones and pedestrian dense urban environments, risk varied from high to medium and outrage factors were elevated. While the absolute crash frequency may be lower than on rural highways, the presence of vulnerable road users, particularly children, activates strong moral and protective responses.

Outrage dimensions related to vulnerability, fairness, and identifiability of potential victims were consistently triggered. The visibility of children and pedestrian activity increases memorability and reduces diffusion of risk. In these contexts, reductions in speed are more readily accepted because perceived risk aligns more closely with objective risk.
This quadrant demonstrates that when risk and outrage are reasonably well aligned, implementation barriers are reduced and policy change is more durable.

Low to Moderate Risk, High Outrage: Localised Speed Reductions
In some peri urban or residential contexts, objective risk may be moderate or already partially mitigated through infrastructure treatments. However, outrage may be elevated due to perceived unfairness, perceived revenue raising motives, or loss of personal autonomy.

Here, outrage is driven less by vulnerability and more by perceived restriction of control or voluntariness. The mapping framework identifies these contexts as potentially contentious despite lower comparative trauma risk.

This finding highlights that outrage is not exclusively associated with high casualty environments but may also be triggered by governance and fairness perceptions.

Low Risk, Low Outrage: Forgiving Urban Arterials with Clear Rationale
Urban arterial roads with clear separation, speed calming at conflict points, and visible risk cues tended to generate lower outrage when speed limits were aligned with observable road function. Where the road environment visually communicated constraint and vulnerability, perceived risk more closely tracked scientific risk.

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In these contexts, neither risk nor outrage was disproportionately elevated, and speed settings were generally viewed as legitimate. This alignment suggests that self-explaining road design can moderate perception gaps.

Cross Context Patterns

Across all environments, three recurring patterns emerged:

- Perceived personal control consistently reduced perceived risk, even where objective risk was high.
- Vulnerability and identifiability of potential victims amplified outrage and increased support for speed reduction.
- Collective risk reduction benefits were weakly perceived at the individual level, particularly in dispersed rural trauma contexts.

Overall, the findings support the central proposition that resistance to speed limit reform is not random or irrational, but predictable when analysed through the interaction between risk and outrage. The structured mapping framework provides a systematic way to anticipate perception driven implementation barriers and to align Safe System speed management strategies with documented cognitive and social processes.

Benefits to road safety

By integrating crash evidence with risk perception theory, this approach helps predict where speed reforms will face resistance and where they will gain support. This improves policy design and communication, increasing the likelihood that evidence-based speed reductions are implemented and sustained, ultimately reducing death and serious injury.

Implications for policy and/or practice

For policy makers and practitioners, the findings highlight that technical evidence alone is insufficient to secure durable speed reform. Effective implementation requires deliberate management of both risk and outrage. This means pairing speed limit changes with visible system improvements, transparent decision making, and context specific communication that addresses perceived fairness, control, and vulnerability. Embedding risk perception considerations into speed zoning processes can strengthen legitimacy, reduce backlash, and support more sustainable Safe System outcomes.

Conclusions

This research demonstrates that the gap between speed management evidence and community acceptance is neither accidental nor irrational. It is structurally linked to the interaction between objective risk and socially constructed outrage. High trauma environments do not automatically generate high public concern, particularly where driving is familiar, voluntary, and perceived as controllable.

By systematically mapping Sandman's outrage dimensions to speed limit contexts, this study provides a practical framework for anticipating perception driven resistance and aligning Safe System evidence with community response. Bridging risk and outrage strengthens the translation of evidence into action, supporting more effective, legitimate, and sustainable speed management reforms that reduce death and serious injury.

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Thriving without driving: developing an evidence-informed toolkit for driving retirement

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Abstract
Driving retirement is a significant life transition for older adults, yet many do not plan for it despite its emotional, practical, and social consequences. Cessation of driving is commonly associated with mobility difficulties, reduced wellbeing, and strong negative emotions, including grief, frustration, and loss of identity. The dual process model of coping with bereavement provides a useful framework for understanding this transition by distinguishing between loss-oriented stressors (emotional responses to giving up driving) and restoration-oriented stressors (adapting to new routines). This study examined the applicability of this model within a workshop-based intervention designed to support planning for and adjustment to driving retirement. Twenty-five participants evaluated an evidence-informed, three-hour workshop addressing emotional, practical, and mobility-related aspects of the transition using surveys administered before, one week after, and six weeks after the workshop. Content analysis indicated strong alignment with the dual process model. Participants reported reduced grief and practical concerns, increased consideration of alternative transport, and greater emotional validation, followed by adoption of new mobility strategies over time. These findings informed the development of an online toolkit to support older adults transitioning to driving retirement.

Introduction
Driving plays a central role in maintaining independence, mobility, and wellbeing in older adulthood (Webber et al., 2010). Although licence retention among older adults is increasing, age-related changes are associated with greater crash risk and driving errors, meaning that most individuals will eventually need to retire from driving (Cox & Cicchino, 2021). Despite this inevitability, planning for driving retirement is uncommon. Many older adults avoid thinking about or preparing for this transition due to the distress it evokes (Waitt, 2022). Unplanned driving retirement has been shown to exacerbate negative outcomes, underscoring the importance of early and proactive planning for this significant life transition (Schofield et al., 2023).

Driving retirement is consistently associated with a range of adverse emotional, social, and health outcomes. Older adults who stop driving often experience reduced participation in activities, increased isolation, and declines in physical, cognitive, and mental health (Liddle et al., 2024). The emotional impact of driving retirement is particularly pronounced, with many individuals' reporting grief, frustration, loss of independence, and threats to identity, especially when the decision feels externally imposed or unexpected (Liddle et al., 2024).

Stopping driving is not a single event. Like the stages of grief, stopping driving is a process during which an individual must work through on-going challenges (Liddle et al., 2024). This process starts before they have stopped driving, with many reporting stress about the future and what will happen when they stop driving (Waitt, 2022). As driving retirement encompasses a transition period focused on changes in the identity of older adults that give way to a new way of living, understanding bereavement as a coping strategy is important in this context. The dual process model of coping with bereavement proposes that the task of adapting to a loss is a process of adjustment that occurs when a person attends to two different types of stressors: loss-oriented stressors (emotional responses to loss) and restoration-oriented stressors (adapting to new routines and ways of living; Stroebe & Schut, 2008). This model provides a useful framework for understanding driving retirement as a non-linear process rather than a single event.

Although older adults report a desire for education and support around driving retirement, there are few evidence-based interventions available (Dickerson et al., 2024). Existing resources tend to focus narrowly on safety or emotional wellbeing and rarely address practical mobility planning or the interplay between emotional and practical challenges (Booth et al., under review). In response to these gaps, we developed an evidence-informed, workshop-based intervention grounded in the dual process model of coping with bereavement. The aim of the present study was to examine the applicability of this model within a driving retirement intervention by exploring its impact on participants' feelings about driving retirement, as well as their planning for managing stressors around driving retirement over time. Findings from this intervention will inform the development of an online toolkit to support driving retirement.

Conference theme
Limited resources exist to support older adults transitioning to driving retirement, and those available are not consistently evidence-based. This study responds to that gap by translating empirical research and theory into an evidence-informed, practical online toolkit. Grounded in the dual process model of coping with bereavement and

informed by participant experiences, the toolkit moves evidence into action by providing older adults with accessible strategies to manage both the emotional and practical challenges of driving retirement. In doing so, this work demonstrates how research can be directly operationalised to support safer decision-making, wellbeing, and mobility outcomes, aligning with the ARSC2026 theme *From Evidence to Action: Shaping a Brighter Future*.

Method

Design and Workshop

We conducted a longitudinal qualitative study to examine the impact of a driving retirement workshop on older adults' loss-oriented and restoration-oriented stressors. Participants completed open-ended questionnaires at three timepoints: pre-workshop, one week post-workshop, and six weeks post-workshop. The workshop was delivered face-to-face by clinical psychologists and driver retirement experts and ran for three hours. The workshop introduced participants to the dual process model of coping with bereavement and was structured around three components: identifying emotional and practical concerns related to stopping driving, learning evidence-informed strategies to support wellbeing, and planning for maintaining mobility after driving retirement. The study had ethics approval.

Participants

Participants were recruited through social media and community organisations and included older adults who were considering or had recently retired from driving. Of those who attended the workshop, 25 participants completed surveys at all three timepoints with ages ranging from 64 to 93 years.

Measures and Data Analysis

Data were collected via online surveys administered at three timepoints using a series of open-ended questions designed to capture participants' feelings about driving retirement, their plans for managing emotional responses, and their strategies for maintaining activities of daily living. Additional questions at follow-up assessed whether participants had begun enacting these plans and how the workshop influenced their thinking. Responses were analysed using content analysis, with two researchers independently coding the data in NVivo to identify recurring themes grounded in participants' own language. Codes were reviewed collaboratively to ensure consistency and analytic rigour with discrepancies resolved through discussion with a third reviewer. The frequency of responses which adhere to each of the codes were calculated to determine the level of endorsement participants had for ideas (expressed as a percentage of the total number participants). Participants may have expressed more than one idea in their response, and as such the sum of the frequencies across the codes will not equal 100%. These frequencies were examined across the three timepoints to examine how perceptions changed from before to after the workshops. Reflexivity and integrity were supported through team discussions and followed adherence to APA qualitative guidelines.

Results

Concerns and Feelings About Driving Retirement

Prior to the workshop, participants reported concerns primarily related to reduced mobility, uncertainty about alternative transport options, impacts on daily activities, and wellbeing. Across all timepoints, participants expressed a mix of acceptance and negative emotions regarding stopping driving, including grief, frustration, and concerns about practical implications. Acceptance was both proactive and reluctant in nature. Immediately following the workshop, reports of grief and practical concerns decreased, although grief increased again at six-week follow-up, consistent with a non-linear adjustment process. Acceptance remained relatively stable over time, while frustration and practical concerns showed an overall decline.

Managing Loss-Oriented Stressors

At baseline, many participants described resignation or uncertainty regarding how they would manage their emotions. Following the workshop, resignation disappeared and participants increasingly reported planning and changes in perspective as strategies for managing feelings related to driving retirement. By six weeks post-workshop, a greater proportion of participants described reframing the transition and focusing on future possibilities. Approximately 42% of participants reported enacting new plans by follow-up, with these actions largely practical in nature. Participants also reported that the workshops helped them feel more comfortable managing their emotions, particularly through validation, shared experiences, and improved emotional awareness.

Managing Restoration-Oriented Stressors

Across timepoints, participants identified a range of strategies for managing activities of daily living after driving retirement. Use of public transport was the most frequently endorsed option, with increased consideration of active transport, rideshare services, support from loved ones, and home delivery services following the workshop. Some participants reported uncertainty about how they would manage daily activities at later timepoints, reflecting ongoing adjustment and lifestyle reconsideration. By six-week follow-up, 42% of participants had begun trialling alternative mobility strategies, most commonly public transport and seeking support from others. Participants increasingly reported that the workshops helped them plan for practical alternatives and feel more comfortable with maintaining daily activities over time.

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Building an Evidence-Informed Toolkit

The findings from this workshop have been used to develop an online toolkit to assist older adults with transitioning to driving retirement. Based on the feedback, the toolkit included strategies trialled in the workshops to support managing both loss and restoration-oriented stressors. This toolkit will be freely available from May 2026.

Benefits to road safety

By proactively addressing driving retirement as a planned, supported transition, this evidence-informed online toolkit will help reduce the likelihood of older adults continuing to drive when it is no longer safe. By equipping older adults with both emotional coping strategies and practical mobility planning, the toolkit promotes safer decision-making, earlier self-regulation, and smoother transitions away from driving while maintaining wellbeing and community participation.

Implications for policy and/or practice

The findings from this workshop have been used to develop an online toolkit to assist older adults with transitioning to driving retirement. This toolkit can be promoted to older adults who are considering retirement from driving to assist them with planning and should be provided as a resource by licencing agencies and practitioners when older adults have their licence revoked to help support their wellbeing.

Conclusions

This study demonstrates that driving retirement is a multifaceted life transition that evokes both emotional and practical challenges, and that the dual process model of coping with bereavement provides a valuable framework for understanding and supporting this shift. The workshop-based intervention helped participants identify and validate their emotional responses while expanding their awareness of mobility alternatives and everyday coping strategies. Importantly, findings highlight that adjustment to driving retirement is not linear; older adults oscillate between loss- and restoration-oriented coping as they navigate this change. The gradual emergence of new mobility behaviours and perspective shifts suggests that psychologically informed, proactive, and practical supports can facilitate healthier adaptation. It is important to acknowledge that this study was completed with participants who self-selected to participate thereby already having an interest in driving retirement, and therefore may not be representative of the general population that may include people who are a lot more resistant to driving retirement. It is important that future research is conducted on the useful of the website toolkit because as populations continue to age, scalable interventions that address both emotional wellbeing and practical mobility planning will be essential. Future work should focus on tailoring resources to local transport contexts, providing ongoing and individualised support where needed, and ensuring older adults have adequate time and guidance to prepare for a safe and empowered transition away from driving.

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DRAFT

Road To Life: driver education through community led action

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Abstract
This project addressed rural community disparities in New Zealands Far North to access comprehensive driver education. Target participants were those that did not hold a drivers licence or held an incorrect licence, and had limited access and resources. New Zealand's Far North District has a high proportion of unlicenced drivers, particularly in isolated rural areas. Community partnerships were established to create a supportive learning environment. Hands-on learning stations were developed and qualified staff determined student test readiness, ensured correct identification, conducted practice tests and assessment drives, and provided access to a mobile testing unit and qualified Community Driver Testing Officer (CDTO). Of the 147 participants, 100% passed their driver licence test at first attempt, resulting in 51 learner licences and 96 restricted or full licences. Findings from learner engagement highlighted the learning environment, transport, financial hardship, anxiety, and literacy challenges associated with gaining a driver licence in rural areas.

Background
A community education organisation led this project and had strong connections throughout the Far North of New Zealand. Community engagement identified traditional classroom delivery that did not work for many participants who live in rural, remote areas. The Far North District experiences a range of challenges and barriers to accessing services, community education opportunities, and healthcare. These barriers include limited access to driver licence testing, restricted access to roadworthy or available whānau/family vehicles, and broader socio-economic challenges.

Rationale (2026) reported that more than one million people aged 16 years and older in Aotearoa New Zealand currently do not hold a full driver licence and nearly half of them have no licence at all. Disadvantaged and vulnerable communities, including Māori and those in rural areas, are disproportionately represented in these numbers, as well as in road crash deaths, serious injuries and licence infringements.

The Road To Life project improves outcomes for young road users by providing educational components that not only prepares participants for their driver licence test but also promotes safer road use. This project aligns with best practice learner support through a holistic, wrap-around approach focusing on helping participants gain the legal and correct driver licence while recognising the environmental and social factors that may otherwise prevent them from achieving this goal.

"A driver licence is more than just a permit to drive a vehicle. It allows access to a range of social and economic benefits. Those lacking a licence may find it harder to find a job, access education and training, and participate in other aspects of society. Driving without a licence puts drivers and others at higher risk of death or serious injury and can incur driving infringements which can lead to more serious interactions with the justice system. A licence connects people to their communities, supports participation in society, and gives people a sense of mana and independence. It is also estimated that over 70% of jobs and up to 85% of entry-level jobs require a driver licence." (Rationale, 2026)
For many people of the Far North, obtaining the correct licence through a programme that provides access, support, and education can lead to a broader understanding of road safety and improve life outcomes beyond the licence itself.
The lead organisation has delivered successful evidence-based community need programmes for many years. This experience has generated a strong understanding of the challenges faced by local communities, including health and wellbeing issues, such as anxiety, trauma, and other mental health concerns; a population often described as the 'working poor', high levels of social isolation; and, for some, a reluctance to obtain the correct driver licence, or attempt to retain one.

Alongside road safety statistics for the Far North, unemployment rates and income disparities remain significant concerns. Without a coordinated and intensive people-centered approach, these barriers are likely to persist. Based on previous mechanisms for supporting licence attainment, the lead organisation is confident that the number of people holding a legal or current licence will not improve without targeted intervention.

Relevant Statistics
According to Statistics NZ socio-economic deprivation index, the Far North's most deprived represents 39.8% of the local population compared to that of 10.3% for all of NZ. (Stats NZ, 2025)

The 2024 NZTA Communities at Risk Register (NZ Transport Agency, 2026), statistical data of personal risk using fatality and serious crash information, shows the Far North District is of high concern in the following road safety focus areas: All Deaths and Serious Casualties, Young Drivers (of light vehicles aged 16-24), Alcohol &/or Drugs, Speed (too fast for the conditions), Urban Intersections, Open road loss of controls &/or head-on (speed zones >70km/hr), Motorcyclist Involved, Distraction (crash factor: attention diverted), Fatigue and Restraints (seatbelt not worn).

To include education on these focus areas, within a driver licencing course, increases individual knowledge, skills and abilities to contribute to lowering the risk for the district.

Stats NZ (2025) report 49.9% of the Far North District population identify as Māori compared to 17.8% for all of NZ. The unemployment rate for the Far North District in December 2025 was 7.6% compared to a NZ overall measure of 5.3% (Infometrics, 2026). The median personal income for residents of the Far North is $29,700 against $41,500 for the whole of the country (Stats NZ, 2025)

Conference theme

The evidence highlights a range of road safety barriers and challenges faced by people in the Far North, including geographic isolation, low socioeconomic status, and limited access to employment. Addressing these challenges requires a community-led, multi-funded approach that provides holistic, wraparound educational support tailored to individual needs and maximises opportunities for learning in culturally appropriate and well-resourced environments. Such an approach will help people in the Far North become more connected and engaged, contributing to a more positive and prosperous intergenerational future in road safety and beyond.

Project description

The Road to Life concept emerged from a forum of Far North education providers, which highlighted the need for rangatahi (young people) and their whānau/families who were facing social and educational challenges and required a different approach from traditional learning environments to obtain their driver licence. The Road to Life project aimed to create a learning environment that met learners in their own communities, surrounded by familiar faces and support networks. The vision was to provide a positive, interactive learning experience that rebuilt confidence and demonstrated what success could look like.

The road safety delivery component was developed in collaboration with relevant social service and community organisations that referred clients to the programme. The programme featured a series of road safety learning stations with multiple-choice activities that participants completed at their own pace, creating a relatable, supportive, and pressure-free learning environment.

The stations covered topics including decision-making under pressure, awareness and stopping distances, collisions and their consequences, building stability, child restraint education, planning ahead, and impairment. Guest speakers were invited to share their expertise and experiences, including a breathing techniques facilitator who provided strategies for managing anxiety, as well as emergency service personnel and funeral directors who shared real-life stories to highlight the impact of road crashes on individuals, whānau, and communities.

Participants were supported to obtain the identification required for driver licence testing and were provided with access to learner licence practice tests, a mobile testing unit for learner licence assessments, an I-Endorsed driving instructor for pre-test assessments for restricted and full licences, and a Community Driver Licence Officer who delivered practical driver licence testing.

The Road to Life project was delivered across three communities:

- Te Hāpua: 13–17 September 2025
- Regent Training Centre (RTC), Kaitaia: 13–16 October 2025
- Te Rūnanga o Te Rarawa: 10–14 November 2025

Results

A total of 147 participants took part in the Road To Life project in 2025. All participants who sat a learner, restricted or full driver licence test passed on their first attempt, resulting in a 100% pass rate across all licence classes. These results compare favourably with Northland driver licencing pass rates reported for 2023, which were 58.4% for learner licences, 61.0% for restricted licences, and 72.2% for full licences (NZ Driving Test Routes, 2026)

Benefits to road safety

According to the NZ Road Safety Strategy Objectives (Ministry of Transport, 2026), the high rates of deaths on New Zealand's roads call for a new approach to road safety. The Road to Life project delivers and succeeds through Principle 3 of the strategy objectives, which states that road safety should be delivered in an efficient and cost-effective way that achieves value for money and considers the regulatory burden placed on New Zealanders.

Table 1. Road To Life Driver Licence Testing results (100% pass rate)

Community Organisation	Learner Driver Licence (Theory)	Restricted or Full Driver Licence (Practical)
Te Hapua	15	29
RTC Kaitaia	22	28
Te Rūnanga o Te Rarawa	14	39
Total	**51**	**96**

Road to Life also supports Principle 4 of the Strategy Objectives, which emphasises that road safety is everyone's responsibility. Due to the project's target demographic, the outcomes of this project also meet the objective to deliver education initiatives to support New Zealand Police enforcement and encourage behavioural change and support road users in making safer choices, particularly among young drivers and other at-risk audiences.

The project delivers these outcomes through a multi-funded model that includes NZTA funding for driver licence costs, access to driver training vehicles, and a Community Driver Testing Officer. These initiatives contribute to achieving the NZ Road Safety Objectives by 'identifying opportunities to improve graduate driver licensing systems that take road safety outcomes into account', for example by ensuring drivers are adequately trained while making the licensing process more accessible and affordable.

Road to Life also supports the strategy statement to explore initiatives that improve the disproportionate outcomes of road groups in New Zealand, including young people and rural residents.

The lead organisation delivered this programme through funding from the National Land Transport Programme, NZTA CDTO, NZTA Community Road Safety Fund, Automobile Association, and the Far North District Council. As local government owns and maintains the local roading network and advocates for road safety at the community level, this project contributes to improved road safety outcomes across local communities.

Implications for policy and/or practice

The outcomes of this work are expected to contribute significantly to reducing trauma resulting from road crashes through the delivery of a road safety education programme that supports at-risk, rural, young people to obtain an appropriate, current driver licence within a positive learning environment. The project addresses the barriers and challenges faced by young people in low socio-economic, rural and remote communities in attaining a driver licence. It also enables participants to experience the broader benefits of safe and legal driving, including increased opportunities to engage with and contribute to their communities.

Conclusions

In conclusion, the Road to Life project has demonstrated that a community-led initiative, delivered within a supportive learning environment and underpinned by a multi-funded approach, can significantly improve driver licensing outcomes for at-risk young people in rural communities.

Future project activities will focus on maintaining engagement with community partners and organisations to ensure participants are supported throughout the full Graduated Driver Licensing System in New Zealand. The project will also continue to support new participants from the original communities, while expanding opportunities to other rural communities across the Far North District.

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Systems approach to work zone safety in LMICs

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Abstract
Work zones on road infrastructure projects represent one of the most hazardous environments for both road users and construction workers. Although international standards provide detailed guidance on temporary traffic management and occupational safety during road works, these standards are frequently not implemented effectively in low- and middle-income countries (LMICs). This paper examines work zone safety failures as a systemic governance and implementation challenge rather than isolated operational shortcomings. Drawing on professional experience supervising road infrastructure programs across India, Georgia, and Papua New Guinea between 2013 and 2026, the study analyses recurring deficiencies in traffic management planning, contractor compliance, institutional oversight, and enforcement mechanisms. Evidence from Output and Performance-Based Road Contracts and rehabilitation programs indicates that weak contractor safety culture, limited supervision capacity, and lack of contractual accountability significantly increase crash risks in work zones. The paper proposes a systems-based framework for improving work zone safety through stronger contractual provisions, enhanced supervision practices, and improved institutional accountability.

Introduction
Road construction and maintenance activities expose both road users and construction workers to significant safety risks. Work zones frequently involve temporary traffic diversions, altered road geometries, heavy construction equipment, and increased interaction between vehicles and workers. These conditions create complex traffic environments that require careful planning and effective traffic management.

International standards provide clear guidance on work zone safety practices. For example, the Austroads Guide to Temporary Traffic Management and the FHWA Work Zone Safety and Mobility Rule emphasise the importance of detailed traffic management planning, clear signage, speed management, and worker protection in road work environments (Austroads, 2021; FHWA, 2019). When implemented effectively, these measures significantly reduce crash risks in construction zones.

However, in many low- and middle-income countries (LMICs), work zone safety standards are inconsistently applied. Contractors frequently prioritise project progress and cost efficiency over safety compliance, while institutional oversight mechanisms remain weak. Observations from multiple infrastructure projects suggest that work zone crashes are often symptoms of broader governance and contract management challenges rather than isolated operational failures.

Conference theme
This paper addresses the ARSC 2026 theme “From Evidence to Action: Shaping a Brighter Future.”
Although substantial evidence exists on effective work zone safety practices, the challenge in many LMIC contexts lies in translating these standards into practical implementation during infrastructure delivery. This study demonstrates how stronger governance frameworks, contractual accountability mechanisms, and improved supervision practices can help bridge the gap between established safety standards and real-world implementation.

Project description
The analysis draws on project supervision and contract administration experience from road infrastructure programs implemented between **2013 and 2026** across India, Georgia, and Papua New Guinea. These programs included:

- rehabilitation of secondary road networks
- Output and Performance-Based Road Contracts (OPRC)
- long-term maintenance contracts
- supervision of major road construction works.

Project supervision reports, field observations, and contract administration records were reviewed to identify recurring deficiencies in work zone safety practices.

Previous studies based on these programs have demonstrated that integrating Safe System principles within infrastructure delivery frameworks can significantly improve road safety outcomes (Bhatnagar, 2024a; Bhatnagar,

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2024b). However, observations from these same programs indicate that safety during construction activities remains one of the weakest aspects of road safety implementation

Findings

The analysis identified five systemic drivers of work zone safety failures in LMIC road projects.

Inadequate traffic management planning
Temporary traffic management arrangements are frequently poorly designed or inadequately implemented, leading to confusion among road users and increased crash risks.

Weak contractor safety culture
Safety is often treated as a regulatory requirement rather than a core operational priority.

Limited supervision capacity
Supervision teams often face resource constraints that limit their ability to effectively monitor contractor compliance.

Lack of contractual accountability
Many infrastructure contracts lack measurable safety performance indicators or meaningful penalties for non-compliance.

Inadequate worker protection
Construction workers are frequently exposed to traffic hazards due to insufficient training, lack of personal protective equipment, and inadequate traffic control measures.
Evidence from infrastructure programs in India and Georgia suggests that when safety provisions are embedded within contract frameworks and actively enforced through supervision mechanisms, work zone safety outcomes improve significantly (Bhatnagar, 2025).

Proposed Systems-Based Approach to Work Zone Safety

The findings indicate that improving work zone safety requires a Safe System approach that recognises that road users will inevitably make mistakes and that temporary work environments must be designed so that those mistakes do not result in death or serious injury. Effective work zone safety requires managing speed, separation, and visibility, ensuring that road users encountering construction activities are guided through predictable, forgiving traffic environments.

In many LMIC projects, work zone safety is treated as a compliance requirement rather than a system design responsibility. A Safe System–aligned framework requires that safety be engineered into the entire infrastructure delivery process. This includes designing work zones that manage vehicle speeds, provide physical separation between traffic and workers, and ensure clear and forgiving traffic control layouts. Contractual frameworks must require risk-based traffic management planning and enforce measurable safety performance obligations. Supervision teams must actively manage safety risks during construction, while road agencies must provide strong institutional oversight. Through this integrated approach, work zone safety becomes a core system responsibility rather than an afterthought of construction management.

Benefits to road safety

Improving work zone safety management has the potential to significantly reduce crashes, injuries, and fatalities associated with road construction and maintenance activities. In many LMIC road projects, inadequate temporary traffic management, poor signage, and weak supervision expose road users and construction workers to high-risk conditions. By strengthening traffic management planning, enforcing safety compliance through supervision, and embedding safety performance requirements within infrastructure contracts, road agencies can substantially reduce these risks and improve safety outcomes during construction works.

Adopting a systems-based approach to work zone safety also contributes to broader road safety improvements by strengthening institutional accountability and contractor safety culture. Integrating work zone safety requirements into contract frameworks, supervision practices, and project governance mechanisms ensures that safety is treated as a core operational priority rather than a compliance exercise. Such measures can lead to safer work environments for construction workers and improved protection for road users travelling through construction zones.

Implications for policy and/or practice

Improving work zone safety in LMIC road projects requires systemic reforms across infrastructure delivery systems. Key measures include:

- mandating detailed traffic management plans within contract documents
- introducing safety performance indicators linked to contractor payments
- strengthening supervision and compliance monitoring
- improving worker training and occupational health standards.

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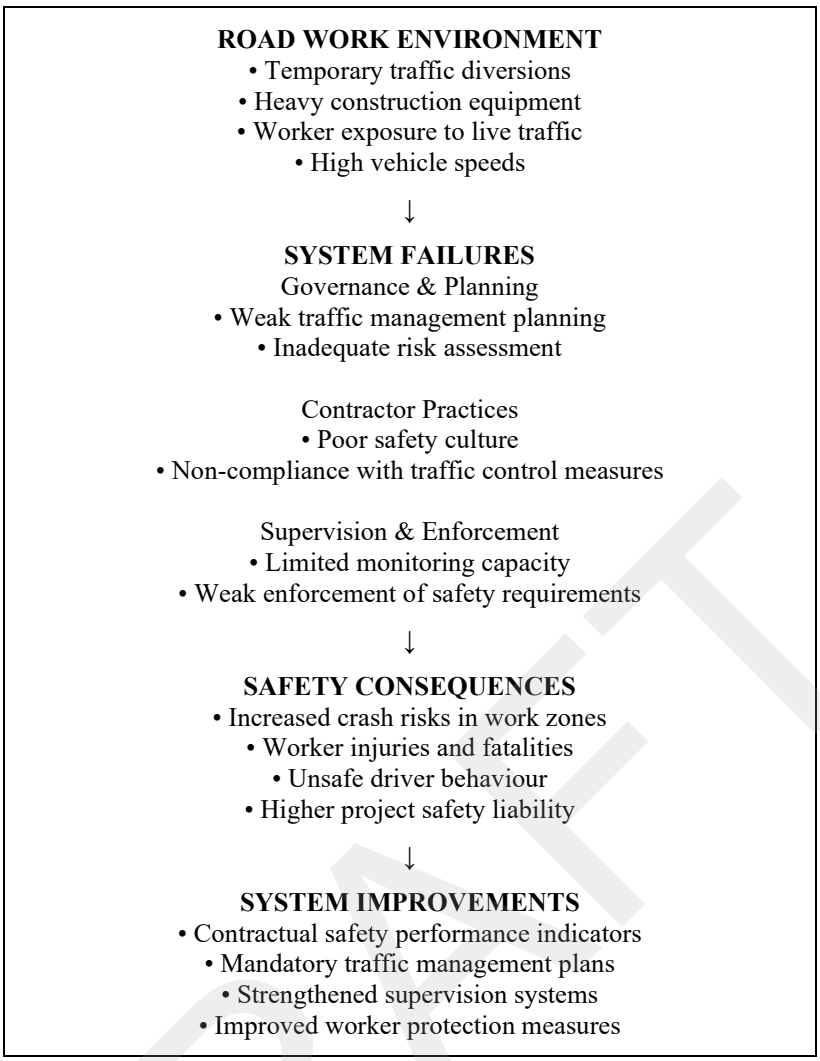

Figure 1. Systemic causes of work zone safety failures in LMIC road projects

Conclusions

Work zone safety failures in LMIC road projects are not simply operational issues but reflect broader weaknesses in governance, contract management, and institutional oversight. Improving safety outcomes requires integrating safety considerations into infrastructure delivery systems and strengthening accountability mechanisms across contractors, supervision teams, and road agencies. A systems-based approach to work zone safety management can significantly reduce risks for both construction workers and road users.

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Leveraging influencers to reach youth in the digital age

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Abstract
The overrepresentation of young road users amongst Queensland road fatalities, paired with a divergence from traditional media towards digital platforms, underscores the need for targeted and innovative communication via social media. Research shows that young people are more likely to listen to their peers and social media influencers rather than traditional authority figures. As such, Queensland's Department of Transport and Main Roads' (TMR) road safety education program, StreetSmarts has begun leveraging influencers to deliver road safety content to at risk road user groups, particularly young people. Influencer content has reached 9.6 million people since 2024, with comment sentiment, high engagement volume and market research showing it resonated strongly with young road users. When aligned with the right message and audience, influencers can serve as highly effective conduits for public education, helping to shift attitudes towards road safety.

Background
Queensland recorded 305 road fatalities in 2025, the highest in a decade, following several years of persistently high death tolls (296 in 2022, 273 in 2023, and 301 in 2024) (TMR, 2025). Road crashes remain a public health challenge with more than 7000 people hospitalised each year, with road trauma costing $7 billion annually (TMR, 2022; TMR, 2026). Young drivers and riders (17 to 24) remain overrepresented in the road toll, making up 13% of licence holders, yet 17.3% of fatalities. Similarly, this group are 60% more likely to be involved in a serious crash than mature adults (TMR, 2025). This overrepresentation underscores the need for targeted public communication and education as part of a broader approach to reducing road trauma involving policy, enforcement, and engineering. Reaching 17 to 24 year-olds is challenging as their media habits shift from traditional channels like TV and Facebook towards a range of digital platforms. Australia has around 26.2 million individuals using social media, where 76% spend an average of over six hours per week on social platforms and Gen Z spend 10 hours per week on platforms (Kemp, 2025; Sprout Social, 2025). Influencers play a key role in this ecosystem: 73% of Australians aged 15 to 40 follow at least one (Behavioural Architect, 2022). Research shows young people are more likely to trust information from social media and influencers than from traditional authority sources, and they are more likely to adopt behaviours modelled by relatable peers (Parker et al., 2013; Eslami et al., 2024).

Conference theme
Research shows that young people are more likely to listen to their peers and social media influencers rather than traditional authority figures (Parker et al,. 2013; Eslami et al., 2024). TMR's road safety education program, StreetSmarts, has turned this insight into an opportunity to expand marketing tactics to include influencers across youth channels. Through influencers that hold peer credibility and audience trust, StreetSmarts has engaged with high-risk young road users to make safer decisions, shifting the focus from negative consequences to safe choices.

Project description
StreetSmarts delivers year-round road safety education to Queensland road users, encouraging personal responsibility for road safety, with a particular focus on young drivers aged 17-24 years. The program leverages platforms like Facebook, Instagram, TikTok, YouTube, Reddit, Snapchat, Twitch, and Spotify to engage 1.5 to 2 million road users monthly, motivating road users to interact, share with friends, and explore web resources.

In 2024, StreetSmarts expanded its strategy to encourage young people and high-risk road users to take personal responsibility for road safety by using creators and voices outside of government channels. The campaign partnered with a major "Hero" influencer alongside five micro-influencers representing young drivers, regional road users, bicycle and motorcycle riders across Meta, TikTok, Twitch and YouTube. Content addressed the fatal five causes of road trauma - drink driving, speeding, distractions, fatigue, seatbelt use, as well as the emerging issue of e-scooter safety. Creators delivered messages in their authentic style, fostering trust, encouraging audiences to recognise and address risky behaviours to become safer road uses.

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Youth influencers were selected for audience relevance, reach and brand safety. For example, Jon Wyeth, Wolf of Brisbane and Money Mitch, are comedy creators who attract a young male audience, a group who are over-represented in high risk behaviours and fatal crashes. TMR commissioned market research shows that entertainment is an effective vessel for road safety messages, and the humorous approach of these creators allowed audiences to engage with their content (Table 2). Billy Slater, legendary Australian player and head coach of Queensland's State of Origin team was StreetSmarts' Hero influencer, selected because of his significant social media following (500,000), 62.4% who are males aged 17-44. His content addressed important issues relevant to his audience including towing, regional driving, P plate safety, mood and driving, and Queensland Road Safety Week, positioning him as Queensland's "road safety coach".

Results

Since its inception, the StreetSmarts influencer program has reached 9.6 million people across Meta, Tik Tok, YouTube and Twitch. Youth targeted content on Instagram and Tik Tok, achieved significant likes, comments and shares, generating more than 30,000 engagements (Table 1). The high volume of shares indicates the content was highly relatable, with positive reception of messages, tone and execution (See table 2). Comments praised influencers for their creative delivery, helping them learn new information, with comments supporting the road safety message (Table 2). Research focus groups corroborate this, with positive remarks from young participants towards content (Table 3). Conversely, when content felt divorced from the creator's style, audiences reacted less positively. This reinforces the importance of ensuring creators align messaging with their tone of voice to engage audiences.

Between 2024 and 2025, Billy Slater's road safety videos reached more than 1.38M people via his Instagram and owned StreetSmarts channels. The impact of engaging a macro influencer, and celebrity role model to deliver road safety messages was evident both in engagement metrics, and positive sentiment of comments. Twitch influencer content delivered strong results and exceeded benchmarks, with creator live streams reaching 11,000 people per stream and maintaining an average of 700 people engaging in each live chat - above the Australian benchmark (100 to 200).

Table 1. Youth Influencer Engagement and Reach 2024-25

Influencer	Video / Topic	Reach	Reactions	Comments	Shares	Saves
Jon Wyeth	Drink Driving (Schoolies)	648,980	4367	55	102	178
	E-scooter Drink Riding		2954	96	230	111
	Speed		7364	125	X	X
Mitch Dale	Mobile Phone Distractions	834,815	4337	31	576	107
Wolf of brisbane	E-scooter Safety	2,049,613	8957	66	303	77
	Drink Driving		638	9	29	18
Total		3,533,408	28,587	382	1240	491
Aiden and Maddy (Included youth viewers)	Road Trip Safety	555,959	2655	45	628	503
	Fatigue - Road trip rest stops	520,256	527	17	156	74

Table 2. Youth Influencer Post Comments 2024 - 2025

Influencer	Video / Topic	Positive Comments
Jon Wyeth	Drink Driving	"Doing god's work" "Thank you for your service" "I support this message" "Legend, you are"
	E-scooter Drink Riding	"And don't leave them in the middle of the path when you are done!" "Pretty sure it is also illegal to ride one under the influence" " 👏👏" "It's also illegal to ride under the influence so even if you don't die, you'll get slapped with an unpleasant fine."
	Speed	"Thanks for this I'll let @josh_hannan06 know" "The entirety of Prep Ls condensed into a short video. This is more fun to watch" "Love a safe king"
Mitch Dale	Mobile Phones	"That final line … I was SO close to spitting tea everywhere." "Love the stuff mate" "so true, lots of people think these things!"
Wolf of Brisbane	Drink Driving	"Pretty decent ad, tbf" "King ish" "I will be doing this thanks king!" "Planning on riding that bad boy completely sober this weekend, even going to put my helmet on"

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Table 3. Market Research Focus Groups - Youth Influencer Content

Influencer	Video	Quotes - Focus Group Feedback
Jon Wyeth	E-scooter Drink Riding	"It was funny but also serious. Okay, wear a helmet!"
	Speed	"If that was on TikTok, I would stay. I would watch it." "It's quick rapid tips in a style that works""He's just like me for real"
Wolf of brisbane	E-scooters - Safety Tips (Helmets)	"This one feels a bit more natural." "I might stick around and watch this one"
	Drink Driving	I can relate to this situation, the idea of going out and planning how to come back home."
Aiden and Maddy	Road Trip Safety	"This is educational, you understand what you're getting into - it's about travelling around Queensland."
Billy Slater	Hero Video - One Team Queensland	"It tugged on the mateship for Queenslanders," "I would let Billy tell me what tyre pressure to use!" "Billy is likeable."

**Data from Footprints market research 2024-2025.

Benefits to road safety

Analysis of TMR data (2012-2022) shows a consistent pattern: decreases in road safety campaign investment are often followed by increases in fatalities (TMR, 2022). As risky behaviours and rule violations contribute to most crashes, ongoing education remains critical to improving decision-making and safety outcomes. Influencer content has strengthened this effort, reaching 9.6 million people since 2024, with comment sentiment, high engagement volume and market research showing it resonated strongly with young road users aged 17-24 who are particularly at risk on the roads.

Implications for practice

StreetSmarts' use of influencers demonstrates how social credibility and peer influence can meaningfully engage young people with road safety. For communication practitioners, this approach offers a clear model for integrating influencers into digital strategy to achieve awareness and attitudinal shifts. Unlike traditional government messaging or standard advertising - often skipped in favour of entertainment - influencers communicate to audiences who actively seek out and trust their content. When aligned with the right message and audience, influencers can serve as highly effective conduits for public education, increasing the likelihood that road safety messages are viewed, absorbed and acted upon.

Conclusion

The StreetSmarts influencer program shows that trusted social media influencer content can successfully reach, engage, and foster positive road safety attitudes and conversations amongst young road users. This approach demonstrates the value of integrating influencers into digital road safety strategies, particularly for audiences less responsive to traditional government messaging. Future efforts should continue investigating the latest social media platform opportunities and creative approaches to maximise impact.

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Safety attitudes and actions of VRUs to shared mobility

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Abstract
Urban mobility routes are increasingly shared by a widening range of users that are often travelling at different speeds. Spaces once clearly designated as footpaths for pedestrians or roads for motorised vehicles now accommodate cyclists, e-scooters, mobility scooters, joggers and even horse-riders. This growing mix is reshaping how so-called vulnerable road users (VRUs) experience and perceive safety and adapt their behaviours. Within the EU/UKRI-funded SOTERIA project, our study has explored VRU attitudes and actions through world café events (n=92) and questionnaires (n=751) conducted across living labs in European countries. The participants were an almost equal mix of genders (Male 56%; Female 44%), representing all age ranges (the highest (27%) being aged 35-44 years) from a wide variety of VRU groups (motorised 35%; non-motorised 65%). Findings across the sample show widespread concerns: 97% report personal road safety as an issue, 88% say route choice is driven by perceived safety and 79% avoid designated shared spaces. Participants frequently attribute safety risks to other user groups. They also show that intensifying spatial sharing is increasingly unacceptable to VRUs and there is a desire for technology-based interventions to be used to improve shared mobility safety.

Introduction
Urban transport systems are undergoing rapid transformations as cities promote active travel, micro-mobility and space-efficient modes of movement. As a result, roads and footpaths that were once clearly segregated by user type are increasingly shared by a diverse and expanding range of mobility users. Pedestrians, cyclists, e-bike and e-scooter users, mobility scooter users, joggers and, in some contexts, horse-riders now routinely occupy the same physical spaces, often travelling at markedly different speeds (Arshi *et al*., 2026). While shared mobility is frequently presented as a sustainable and inclusive solution, its implications for VRU safety remains poorly understood.

While the term ‘vulnerable road users’ is widely used in policy and research, it is important to recognise that vulnerability is not something inherent to individuals, but is shaped by how transport systems are designed, how risks are distributed and how different road users interact (te Brömmelstroet, (2024). In this sense, vulnerability emerges from people’s exposure to road danger, rather than it being a fixed characteristic of a particular type of VRU group. The growing coexistence of heterogeneous users within constrained urban infrastructure has introduced new safety challenges and behavioural adaptations. Emerging evidence suggests that VRUs may alter their route choices, travel times or mobility practices in response to perceived risks; yet responsibility for safety is often contested between user groups (Moody and Melia, 2014). These dynamics raise important questions about whether current shared mobility designs are meeting their intended objectives or unintentionally exacerbating feelings of insecurity and exclusion.

Against this backdrop, there is a pressing need for empirical, user-centred evidence that captures how VRUs experience shared mobility spaces and how these experiences influence their attitudes and actions. Addressing this gap, the present study investigates VRU perceptions of safety and associated behavioural responses across multiple European contexts. Using a mixed-methods approach, within the EU/UKRI-funded SOTERIA project (Booth *et al*., 2025a), the research draws on world café discussions and large-scale questionnaire data collected across living labs in Germany, Greece, Spain and the UK. The aim is twofold: first, to provide a nuanced understanding of the safety challenges emerging from increasingly shared mobility environments; and second, to inform the development of technology-enabled interventions capable of supporting safer, more inclusive urban mobility futures.

Conference theme
This paper directly addresses the conference theme of ‘safe streets and neighbourhoods’ by moving from empirical evidence to actionable outcomes for improving urban mobility safety, namely:

- Evidence generation: The study provides robust, cross-national evidence on VRUs attitudes, behaviours and safety concerns in shared mobility spaces, drawing on qualitative (world café events) and quantitative (large-scale questionnaires) data across four European countries.
- Problem identification: Findings demonstrate that shared mobility environments are widely perceived as unsafe, with VRUs adapting their behaviour (e.g. route avoidance) and often attributing safety risks to other user groups, highlighting a systemic and escalating issue.
- Translation to action: The evidence directly informs the design of practical, technology-enabled interventions within the SOTERIA project, including VR-based tools, safety- and clean-routing apps and bike-mounted cameras.

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- Future impact: By linking lived-experience and behavioural data to design and policy-relevant solutions, the research supports the development of safer, more inclusive shared mobility systems that align with the conference theme through evidence-led action.

Method

This study used a mixed-methods approach to explore the attitudes and behaviours of vulnerable road users (VRUs) in shared mobility spaces. Data were collected as part of the EU/UKRI-funded SOTERIA project across living labs in Germany, Greece, Spain and the UK. Qualitative data were gathered through a series of world café events involving 92 participants, identified through PESTLE-informed stakeholder mapping to capture a broad range of perspectives. These structured discussions gave VRUs and other mobility stakeholders the opportunity to share their experiences, perceptions and challenges, providing rich insights into safety concerns and behavioural adaptations (Sudhakaran et al., 2025). Conversations were recorded and supported by written contributions on tablecloths then analysed thematically using NVivo (v14). Quantitative data were collected through structured online questionnaires (Qualtrics XM Platform), completed by 751 participants across the same living labs. The survey captured perceived safety, route choice, use of shared spaces and views on responsibility for safety incidents (Booth et al., 2025b). The data were analysed using descriptive statistics in SPSS (v29) to identify key patterns and trends. The two sets of findings were brought together to explore where they aligned or offered different perspectives, helping to build a fuller picture of how shared mobility environments are experienced. This combined approach provides a deeper understanding of the interactions, perceptions and behaviours that shape safety in these settings. Together, the findings help identify specific gaps between infrastructure, user behaviour and perceived risk, providing a clear basis for developing targeted interventions, including digital tools and technologies, that respond to these challenges in a practical and user-informed way.

Findings

Analysis of the datasets highlights several key findings, namely:

- Widespread safety concerns among VRUs: Across all living labs, the vast majority of participants expressed concern for personal safety in shared mobility spaces. Specifically, 97% of participants indicated that safety is a significant issue for them. Thus, highlighting a consistent perception of risk when navigating mixed-use roads and footpaths. Qualitative discussions reinforce this finding, with many participants describing situations where interactions with other user groups felt unpredictable or hazardous.
- Safety perceptions shape route choices: VRUs reported that their choice of travel routes is strongly influenced by perceived safety. Eighty-eight percent of survey participants stated that safety considerations directly determine the choice of routes they take. World café participants further elaborate that avoiding congested or high-speed zones, even if longer or less convenient, is a common strategy for managing perceived risk.
- Infrastructure influences behaviour: Participants emphasized the role of urban infrastructure in shaping behaviour, with most (88%) indicating that the design and quality of routes, such as the presence of cycle/bike lanes, footpaths and separation from motorised traffic, affects their mobility decisions. Observations from discussions highlighted that poorly designed shared spaces or unclear lane demarcations often lead to conflict and confusion among different mobility groups.
- Avoidance of designated shared spaces: Most participants (79%) reported that the presence of designated shared spaces, such as cycle/bike lanes, can paradoxically lead them to seek alternative routes. Participants explained that this behaviour often arises from a perception that these spaces are unsafe, overcrowded or inconsistently used by other mobility groups, which suggests that mere provision of infrastructure is insufficient to ensure VRU safety.
- Blame and conflict between user groups: Qualitative data revealed a recurring pattern of participants attributing safety risks to other user groups. Many VRUs expressed frustration with cyclists, e-scooter users or pedestrians who do not follow expected behaviours, indicating that social dynamics and mutual perceptions of responsibility are critical factors that are often influence safety and mobility choices.
- Demand for technology-supported safety solutions: Participants expressed interest in technology-enabled tools (including VR-based tools, safety- and clean-routing apps and bike-mounted cameras) to support safer mobility choices. Nearly three-quarters of participants (74%) indicated enthusiasm for personalised safety- and clean-routing applications. Such tools are perceived as a way to mitigate safety concerns by providing tailored route guidance. Thus, reinforcing the role of digital solutions as a complementary strategy alongside physical infrastructure improvements.

Benefits to road safety

This study provides valuable insights for improving road safety in increasingly shared mobility environments. By identifying the specific perceptions, behaviours and route-choice strategies of VRUs, our study highlights both the risks and how people respond in practice when multiple user groups share the same infrastructure. These patterns can help policymakers, urban planners and transport designers better target interventions where they are most needed. Moreover, the findings also point to a role for supporting technologies because they can both enhance user awareness and inform safer infrastructure design. Overall, the study translates empirical evidence into actionable guidance that can offer pathways to reduce accidents, improve trust among users and also promote safer, more inclusive mobility systems.

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Implications for policy and/or practice

The results of this study have clear implications for both policy and practice in urban mobility planning. Evidence that many shared spaces are experienced as risky or uncomfortable, leading users to change how they move through them highlights the need for regulatory frameworks that prioritize user safety and equitable access. Policymakers can use these insights to set standards for lane design, segregation of different mobility modes and enforcement of safe behaviours. Practitioners, including transport planners and urban designers, can leverage the behavioural data to create infrastructures that better accommodate mixed mobility users, while technology solutions can support safer navigation in real time. By aligning infrastructure, regulation and technological innovation with lived-experiences of VRUs, these findings provide actionable guidance for creating safer, more inclusive and resilient urban streets and neighbourhoods.

Limitations

While the findings provide valuable insights, it is important to consider how they should be interpreted and their limitations. Many participants reported feeling unsafe when using shared mobility spaces, and that these feelings are shaping everyday travel decisions. However, it is important to recognise that this study is based on people's perceptions of safety, rather than measured crash or incident data. What feels risky does not always match actual levels of risk, and these perceptions can be shaped by past experiences, media coverage or uncertainty around newer travel modes, such as e-scooters. The study also relies on voluntary participation, which means it may reflect the views of those who are already more concerned about safety. As a result, the findings may place greater emphasis on negative experiences. In addition, differences between countries, such as infrastructure quality, traffic culture and regulatory approaches, are likely to have also influenced how participants responded, and this should be kept in mind when interpreting the results. A further point of interest is the tendency for participants to attribute risk to other user groups. While this highlights real tensions in shared spaces, it also reflects how people make sense of their experiences, rather than providing objective evidence of who is responsible for unsafe behaviour. Collectively, these findings offer valuable insights into how shared mobility is experienced in practice, but they also point to the need for future research that combines perception-based insights with more objective evidence, such as observational studies, near-miss data or collision records. This would help build a more complete understanding of both perceived and actual safety in shared mobility environments.

Conclusions

This study highlights how increasingly shared mobility environments are shaping how people experience and navigate urban spaces. It shows that safety is influenced not only by infrastructure, but also by how users interpret and respond to interactions with others. Drawing on both qualitative and quantitative evidence, the study highlights patterns in how people respond to shared mobility environments. These findings underscore that simply providing designated shared infrastructure is insufficient to ensure safety; careful consideration of user interactions, infrastructure design and behavioural dynamics is essential. The findings point to the need for a balanced approach, combining well-designed infrastructure, appropriate policy and enforcement, and supporting technologies. Tools such as VR training, routing applications and monitoring devices can support safer and more informed mobility choices. These findings also reinforce the idea that vulnerability on roads and pavements are shaped by infrastructure, policy and user interactions, rather than it residing on individuals themselves. By connecting rigorous evidence with practical applications, this study contributes to safer, more inclusive urban mobility and offers practical guidance for policymakers and practitioners who are working to improve shared mobility environments.

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Incorporating Movement and Place frameworks into speed management practice

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Abstract
Many current speed limits across Australasia were established at a time when vehicle throughput was prioritised, before the full safety risks and wider social impacts of speed were well understood. As evidence around survivability, accessibility, and Safe System principles has evolved, it has become clear that a broad recalibration of speed limits is required. Traditional volume-based road hierarchies have proven to be blunt tools for this task, offering limited insight into how streets and roads actually function. In contrast, the Movement and Place approach provides a more nuanced framework by reflecting land use and the type, mix, and intensity of road users. Embedding Movement and Place principles into speed management enables more appropriate, evidence-based speed limit decisions and helps balance competing needs. It also supports clearer, more constructive conversations with communities about aligning speed limits with the surrounding environment and risk.

Background
Many current speed limits across Australasia were established at a time when vehicle throughput was prioritised, before the full safety risks and wider social impacts of speed were well understood. As evidence around survivability, accessibility, and Safe System principles has evolved, it has become clear that a broad recalibration of speed limits is required (Austroads, 2025A, 2025C).

Incorporating Movement and Place into speed management practice presents an opportunity to improve and streamline this recalibration process. It is a shift away from a traditional road hierarchy developed around traffic and vehicle priority. It considers all the ways in which people and goods interact with the transport network – not just the movement of vehicles. Importantly, Movement and Place provides a common language and framework that enables shared and integrated planning. This improves decision making and enables better measurement and reporting. It also supports clearer, more constructive conversations with communities about aligning speed limits with the surrounding environment and risk.

Movement and Place frameworks are an ideal framework for determining what a safe speed limit is for different types of roads and streets. This is because Movement and Place street environments provide a proxy for the road users and crash types that might be expected in a given location. These can then be linked with the impact speeds and safe speed limits are most likely to be survivable for expected crash types (Waka Kotahi NZ Transport Agency, 2022).

In contrast, using a traditional classification approach when setting speed limits has significant flaws that have resulted in setting speed limits that are too high to be safe for most roads. These flaws, such as neglecting the safety of vulnerable road users, positioning safety as in conflict with efficiency and being slow to adapt to changing land uses, are outlined in Turner et al. (2024A).

Conference theme
Using a Movement and Place framework to better understand how streets and roads function supports evidence-based action on speed management. It makes it easier to identify, communicate, and implement speed limits aligned with Safe System principles, likely crash types, and the range and intensity of road users present.

Project description
New Zealand, and most Australia jurisdictions have implemented or are currently developing a Movement and Place framework to support integrated land transport planning (Austroads, 2025B). Several jurisdictions have embedded their Movement and Place frameworks into speed limit setting policy. Others are currently in the process of doing this. In the examples of New Zealand (2022 – 2024) and Victoria (2025), Movement and Place categories are linked to speed limit ranges, and the speed limit selected from within the range depends on the presence of safety infrastructure to minimise or prevent certain crash types. These approaches align with the Roads-for-Life (R4L) framework proposed in the Guide for Safe Speeds: Managing Traffic Speeds to Save Lives and Improve Liveability, international guidance prepared by the World Bank and World Resources Institute (Turner et. al., 2024B).

Findings

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This paper describes two examples on the establishment of speed limits using a Movement and Place-based framework alongside Safe System principles. It discusses the common features of such an approach, as well as the challenges, benefits to road safety and implications for policy.

The *Victorian Speed Zoning Policy* (Edition 3 published August 2025) uses street families from the state's Movement and Place Framework (Department of Transport and Planning, 2025). The street families are further refined in the Policy considering the land use context – either within built-up areas or outside of built-up areas. Special cases that do not fit neatly into these street families are also identified as separate road or street categories – including schools, car parks and reserves, peri-urban roads and freeways.

The New Zealand *Speed Management Guide*[1] which operated from 2022 - 2024 used the street categories from New Zealand's One Network Framework for defining street environments and ranges for safe and appropriate speed limits (Waka Kotahi NZ Transport Agency, 2022). These were defined separately for urban and rural street environments, using the One Network Framework's Movement and Place matrices for urban and rural street environments.

In both examples the type of road users and expected crash risks help inform the speed ranges for each street environment – linked to Safe System survivable impact speeds. For some categories, particularly rural ones, these ranges are quite broad to acknowledge the wide range of risk, design and operational characteristics of roads. Typically, the speed limit should be selected from the lower end of the range, unless design, infrastructure and safety criteria are met to justify a higher speed limit.

Incorporating design, infrastructure and safety metrics into the selection of speed limits lifts practitioner understanding of the conditions needed to support speed limits from the upper end of the range. For instance, in urban settings the provision of a separated cycling facility on an urban connector may support selection of a speed limit from the upper end of the range. Similarly, in rural environments, the presence of infrastructure that facilitates safer outcomes, such as flexible roadside and median barrier, will support selection of a speed limit from the upper end of the range.

Benefits to road safety

A Movement and Place approach enables a more nuanced and finer-grained method for setting speed limits, particularly in contexts such as complex urban environments with mixed use, and small towns intersected by high-volume strategic routes. Establishing a principles-based approach reduces reliance on lengthy technical speed reviews and allows more efficient network-wide analysis. The approach is proactive, based on intended function rather than existing traffic volumes, and better accounts for vulnerable road users and the diversity of road users. It creates a link between road safety and transport planning, providing a shared language for joint decisions and understanding about the intended use of roads and related priorities. It also improves communication with communities by linking speed limits to the tangibility of place, as well as values and lived experience.

Implications for policy and practice

Applying a Movement and Place framework requires a more subjective categorisation process than traditional volume-based approaches. This can necessitate review and moderation and may be challenging for some practitioners, particularly those accustomed to the clarity provided by using annual average daily traffic (AADT) counts. In some Australian states and in New Zealand, regulatory settings currently limit or restrict the application of the full range of speed limits needed to fully align Safe System and Movement and Place principles, constraining implementation. It is recommended that jurisdictions and New Zealand, update their policy to allow the full range of speed limits, especially 30km/h, as Victoria has done recently (Department of Transport and Planning, 2025).

Because Movement and Place frameworks serve broader transport and land-use planning purposes, associated matrices can be complex and may need simplification for speed limit setting. These frameworks can also take time to develop, despite the urgency to change speed management practices now given the likely road safety benefits. However, once they are in place, they can support more streamlined and efficient speed limit identification and setting across the network without the need for extensive speed reviews on a corridor-by-corridor basis. Linking speed limits to road classification at a principles level can also enable easier adjustment as land use changes.

Currently, not all jurisdictions have Movement and Place frameworks in place. Jurisdictions without formal Movement and Place frameworks can still begin by applying core principles in a way that is future-proofed for later adoption of a full framework. As a starting point, jurisdictions can take the general principles and use these when establishing speed limit policy. This can then be refined as more detailed policy is developed.

Importantly, this approach can reveal the true scale of change required across networks, which may be difficult for decision-makers to accept or support. While this method may identify a substantial scale of change required to align

[1] Note that the speed limit setting guidance in the *Speed Management Guide* was superseded by the *Land Transport Rule: Setting of Speed Limits 2024*. Regardless, the older Guide is considered a good example demonstrating how Movement and Place can be used as a framework for defining speed limit ranges.

networks with Safe System principles, it is important for elected leaders, decision makers and the public to understand this as a long-term goal, with pace and scale determined locally (Waka Kotahi NZ Transport Agency, 2022).

Finally, internationally, countries including the United States are increasingly looking to Australasian examples to inform their own speed limit setting reforms, including those based on Movement and Place principles (Hsu et al., 2025).

Conclusions

Movement and Place frameworks are increasingly being used across Australasia to support more context-sensitive and evidence-based approaches to speed management. The experiences of New Zealand and several Australian jurisdictions demonstrate that linking road and street function to appropriate speed ranges can better align speed limits with Safe System principles, crash risk, and the needs of different road users. While challenges remain—including regulatory constraints, practitioner capability, and the scale of network change required—the benefits for road safety, change management, and community understanding are substantial. Importantly, this approach shifts speed management from a reactive, volume-based exercise to a proactive, principles-led process which takes movement, place, and safety into account. As jurisdictions continue to refine and embed Movement and Place frameworks, there is a clear opportunity to strengthen consistency, simplify application for speed limit setting, and accelerate delivery. Doing so will support safer, more liveable streets and help translate road safety evidence into sustained, system-wide action.

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Why road safety cameras are important for speed compliance

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Abstract

Road safety cameras play a vital role in managing speeding behaviour on the road network whether under a general or specific deterrence model. Through a recent analysis of network vehicle speeds and fixed road safety camera operations, the Victorian Department of Justice and Community Safety (DJCS) has identified different patterns of speeding behaviours across the enforcement lifecycle – i) without a road safety camera installed, and ii) following installation of road safety camera infrastructure. Additionally, differences in speed behaviours were noted on major freeways in Victoria operating point-to-point cameras compared to other comparable parts of the road network where there is no fixed road safety camera enforcement. This work highlights the impact road safety cameras have in achieving lower travel speeds and improving road safety.

Background

Victoria's road safety camera program has been a foundational component of the state's broader road safety framework since its introduction in 1983. Victoria is recognised as the first location globally to have adopted, at scale, automated speed enforcement (Heidstra et al., 2000). Over several decades, the program has evolved from a relatively small enforcement initiative into a critical component of Victoria's efforts to reduce road trauma. Developed in collaboration with Victoria's road safety partners (the Transport Accident Commission, Department of Transport and Planning, Victoria Police and the Department of Health and Human Services) the Department of Justice and Community Safety (DJCS) has adopted an evidence-based approach to managing speed and other dangerous driving activities across the road transport network. The program aims to compliment the Safe System approach utilised in Victoria, to ensure that crashes do not result in serious injuries or death.

Victoria's camera network operates under an "anywhere, anytime" approach, randomising deployment locations and technologies across the approximately 200,000km plus road network. To achieve this, Victoria adopts a mix of fixed, mobile and distracted driver/seatbelt camera systems. As of January 2026, the fixed road safety camera network has grown to 330 sites active and enforcing (278 intersection sites and 52 freeway sites). Since the first road safety camera was introduced in 1985, Victoria has also adopted new and innovative technologies to identify speeding, red light running and distracted driver behaviours. These technologies, operating in both fixed and mobile configurations, are capable of detecting a wider range of driving offences, across a larger span of the network. In addition, and in line with the Victorian Government's Road Safety Strategy 2021-2030, DJCS is also trialing the latest camera technologies to enhance operational deployment.

A substantial body of research demonstrates the effectiveness of automated speed enforcement in reducing road trauma (Allsop, 2010, Cameron & Delaney, 2008, Elvik et al., 2009, Pilkington & Kinra, 2005). Independent evaluations of Victoria's program have consistently found the program to be effective in lowering crash risk and improving safety outcomes (Budd et al., 2011, Cameron et al., 2003, Victorian Auditor General, 2006). Reflecting on Victoria's Auditor General's findings, Belin, Tillgren, Vedung and Cameron (2010) highlight that Victoria's speed enforcement program represents one of the strongest road safety interventions carried out by the State.

As part of Victoria's commitment to continuous improvement, DJCS has undertaken new analyses of upgraded and newly installed camera sites to understand their effect on speeding compliance. Drawing on two detailed case studies, these evaluations form part of Victoria's broader commitment to the application of contemporary evidence to guide policy and practice. By examining changes in speed behaviour before and after enforcement across these case study sites, the analyses contribute to an expanding empirical base that reinforces the program's role within Victoria's road safety system. Together, these developments underscore the importance of automated enforcement as a crucial road safety intervention for achieving safer travel speeds and supporting long-term reductions in road trauma.

Conference theme

This work adds to the evidence base regarding travel speeds across parts of the high speed road network and the impact that fixed road safety cameras, particularly those enforcing point-to-point average speed, have on reducing speeds to below the posted speed limit.

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Project description

Case study 1

DJCS engaged GHD Digital to analyse speed data from Compass IOT at four locations along the Hume Freeway, North of Melbourne. The first two locations were at existing fixed road safety camera sites in Wallan and Broadford that were upgraded with new technology between June - August 2023. The third and fourth locations (Seymour and Euroa) had fixed road safety camera infrastructure installed in early 2023. Installation of the new cameras has created a continuous link of speed enforcement from Melbourne to Euroa – a distance of 126km. Data was gathered over a three-month period (1 January to 31 March) for each of 2022, 2023 and 2024.

The analysis was able to determine any differences in instantaneous speed at the four locations as well as the average speed travelled between cameras (i.e. across three segments).

Findings

All four locations observed a reduction in the 85th percentile speed between 2023 and 2024, with those reductions ranging from 4.61km/h to 6.73km/h.

Between 2022 and 2024, the average speed travelled between camera locations showed a reduction in the 85th percentile speed of 6.4km/h (Wallan to Broadford), 6.6km/h (Broadford to Seymour) and 7.4km/h (Seymour to Euroa). These reductions coincided with the upgrade of existing sites in Wallan and Broadford and the installation of road safety camera infrastructure at Seymour and Euroa.

Further, the data showed a reduction in the 85th percentile speed between the existing cameras at Wallan and Broadford from 114.4km/h to 108.0km/h with the only change being an upgrade of the camera technology, suggesting that the introduction of new cameras further north on the Hume Freeway may have impacted on drivers' speeding behaviours along a much longer section of the Hume Freeway than just where the new cameras were installed.

Case study 2

DJCS collected speed data from Infra-Red Traffic Logger (TIRTL) devices and compared the rate of compliance with the posted speed limit on:

a) Peninsula Link (where both instantaneous and point-to-point (P2P) average speed is enforced) and the Mornington Peninsula Freeway which is a continuation of Peninsula Link however without any fixed road safety camera enforcement (Figure 1), and
b) Hume Freeway (where both instantaneous and point-to-point (P2P) average speed is enforced) and the Goulburn Valley Freeway which diverges continuously off the Hume Freeway at Seymour and has no fixed road safety camera enforcement (Figure 1).

These roads were selected as they presented comparable road configuration in terms of number of lanes and identical speed limits (100km/h on Peninsula Link and Mornington Peninsula Freeway; 110km/h on Hume Freeway and Goulburn Valley Freeway).

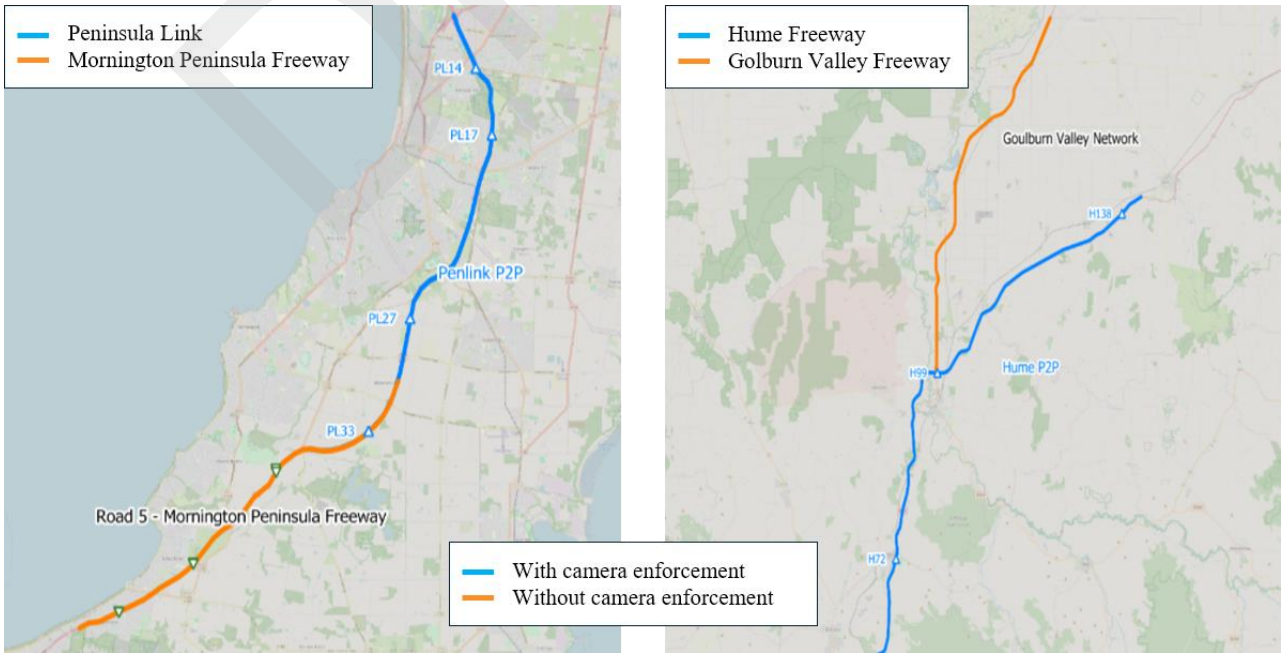

Figure 1. Maps showing the comparison roads analysed in Case study 2.

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Findings
DJCS found that motorists' compliance with the speed limit was 27.72% higher on Peninsula Link compared to the Mornington Peninsula Freeway, and 7.46% higher on the Hume Freeway compared to the Goulburn Valley Highway.

Benefits to road safety

The TAC-funded Enhanced Crash Investigation Study, conducted by Monash University Accident Research Centre (MUARC) found that exceeding the speed limit was found to be a contributing factor for 26.2% of all crashes and 36.6% of MAIS3+ crashes (Fitzharris et al., 2020). Furthermore, MUARC also found that drivers travelling 5km/h above the speed limit had a 45.4% increase in crash risk (Fitzharris et al., 2022).

The findings from the Hume Freeway analysis showed that the upgrade of existing cameras and implementation of new fixed road safety cameras in 2023 has corresponded with a reduction in the 85th percentile speed from around 5km/h over the posted speed limit to 1km/h under the posted speed limit. Combined with MUARC's ECIS findings, it can be estimated that crash risk along this section of the Hume Freeway has decreased by around 45.4% over this period.

Implications for policy and/or practice

This increased understanding of motorists' compliance with speed limits both at and between fixed camera locations provides valuable information when considering the potential for growth of Victoria's fixed and P2P average speed road safety camera networks. Evidence of the increased compliance both at camera locations and along lengths of road between camera locations can be used to help inform future business cases to expand Victoria's fixed road safety camera network. This analysis has helped DJCS to prioritise future sections of Victoria's freeway network that would deliver road safety benefits by implementing P2P average speed enforcement.

Conclusions

The road safety camera program represents a critical element of Victoria's road safety intervention toolkit. The analysis has shown that both new and upgraded sites can reduce 85th percentile speeds to below posted speed limits. Importantly, the results highlight that when compared to sites that have enforcement interventions applied, speeds remain higher where there are no road safety cameras in place. The speed data captured at these sites presented in the case studies provides confidence to both government decision-makers and the general public that these camera systems are effective in achieving compliance with posted speed limits and reducing road trauma.

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“I don’t have trust.” Motives for speaking up as passengers

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Abstract
It is well established that young adults can be influenced by their friends, with this influence extending to road behaviours. Our study sought to understand the motivation for young adult passengers to speak up to prevent their friends’ (i) mobile phone use while driving and their (ii) speeding. Our sample included 174 Queensland young adults (aged 18-25 years, M=19.96 years). Using qualitative methodology, we asked young people to, “describe what might motivate you to speak up” and found key themes, including, the driving environment, driver characteristics, consequences, ‘right thing to do’, emotions as information, personal experience, and solutions. Overall, the findings have implications for promoting willingness to speak up and engaging young adult peers in their shared responsibility on the road.

Introduction
Young people are over-represented in road crashes with many of these crashes associated with speeding behaviour and mobile phone use while driving (PUWD) (e.g., TMR, 2026). Young adults’ driving can be social and thus passengers may be able to play a role in promoting safety and reducing the likelihood of speeding and PUWD. This study seeks to understand young adult passengers’ motivation to speak up to such behaviour. It aligns with a general theme to increase the social responsibility of road behaviour. Better understanding speaking up behaviours can provide the language and nuanced description of what this means in the context of protective behaviour.

Active intervention via speaking up has been identified as a way passengers can buffer against risky driving behaviour, increasing their own and other road users’ safety (see Spence et al., 2026). Research to date has primarily explored individual differences and characteristics associated with speaking up. For example, Basse et al. (2020) found factors associated with speaking up to a speeding driver included risk perception, attitudes, subjective norms (expectation of others) and prototype similarity (being similar to someone who speaks up). Similarly, a review by Buckley et al. (2016) found risk perception and confidence were associated with speaking up to a drink driver along with feeling responsibility for the driver. Additional research has identified factors of self-esteem, perspective taking, and anticipated regret (see review, Spence et al., 2026).

While several characteristics of the passenger have been identified, young adults’ description of their motivations is less understood. Such qualitative work has the potential to enable a better understanding of what young people experience and potentially their lived experience of protective behaviour. A few existing studies provide some background to the passenger experience. The participants in McDonald and Sommers’ (2016) study described ‘good’ passengers as helpful in identifying hazards, providing directions, and monitoring driving tasks (‘bad’ passengers were distracting). Lee and LaVoie’s (2013) young adult passenger participants similarly described ‘good’ as identifying hazards or ‘threats’ as well as helping keep attention on the road and not being distracting. The studies however do not describe speaking up when a driver is not obeying road rules, such as speeding or PUWD. We sought to address this gap and understand how young adults describe their motivation for speaking up if the driver were speeding or using their phone while driving.

Conference theme
Our work addresses a theme of ‘evidence to action’. Our findings provide descriptions of how young adults can directly contribute to safety by speaking up to prevent harms. In doing so we address, ‘What the evidence is telling us?’ By understanding the language and descriptions of young adults’ motivation, it can help inform the way messaging is shaped and how young adults can be influencers in their peer groups. It has the potential to complement other approaches, such as enforcement whereby the social environment can be used to reinforce messaging about rules, policing and consequences.

Method

Participants and procedure
Queensland residents aged between 18-25 years inclusive were recruited through the university first-year psychology undergraduate participant pool and online via social media advertising (Facebook and Instagram). Overall, 174 participants (85% female) with a mean age of 19.96 years (S.D.=1.69), completed an online survey (~10 minutes duration). The study did not require participants to be drivers however 26% reported having an Open licence, 43% a

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Provisional 2 licence, 14% a Provisional 1 licence and 15% had a learner licence or did not drive. Of the drivers, most drove 5-15 hours per week (47%).

Prompts

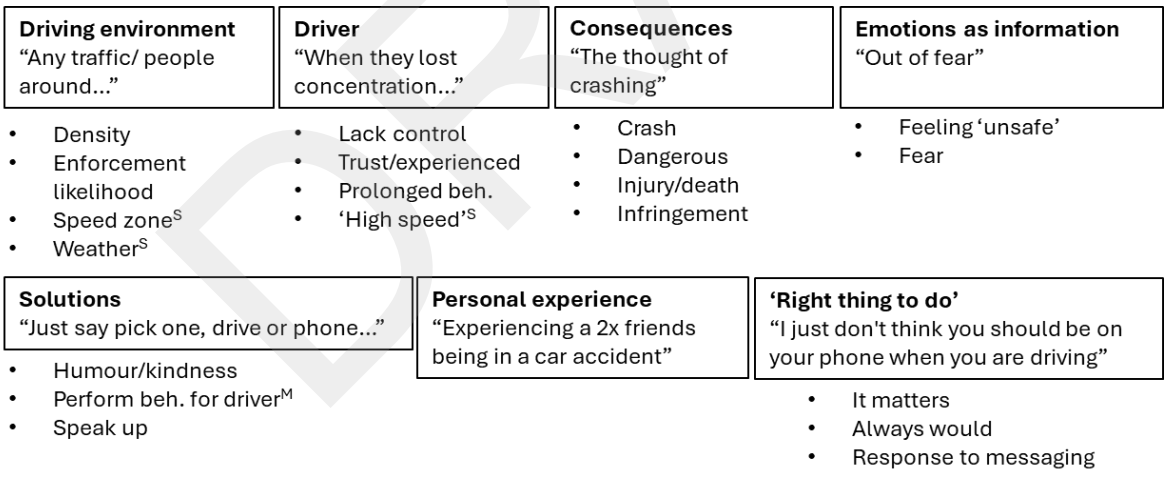
Participant responded to two separate questions on each behaviour, "In the context of [a driver who is using their phone while driving/ a speeding driver who is 10km/h over the limit], please describe what might motivate you to speak up. If you have an example of what has motivated you to speak up in the past, please describe it." Participants were given a free text box to type their answer. Participants also reported their willingness to speak up to a driver who was speeding or using a phone while driving, while those who held a licence were asked to report their engagement in speeding and PUWD (Scored 1-5, not at all willing-very willing).

Data analysis

Qualitative data was analysed utilising Structured Tabular Thematic Analysis (ST-TA) (Robinson, 2022). ST-TA was designed for analysing brief texts drawing on and integrating aspects of distinct approaches to thematic analysis. It offers a flexible approach suited to the current project where responses were brief as part of a survey. Our analysis followed that of Robinson (2022), who suggest eight phases including, a-priori theme development, deep immersion in the data, developing codes and themes, tabulating themes against texts, checking agreement, exploring theme frequencies, producing thematic maps and writing.

Findings

With regard to risky road use, participants who held a licence reported driving >10km/h above the speed limit on a highway (55%), in town (47%), and generally (57%). In addition, 48% of licenced participants reported PUWD at least once per trip. There was also a general willingness to speak up to a speeding driver >10km/h over the limit (M = 2.93, S.D. = 1.23) and to a driver using their phone (incl. holding/resting phone on body; M =3.45, S.D. = 1.22).
Young adults described their motivations, which were developed into seven themes (and multiple sub-themes). Figure 1 provides an overview and an example quote of the theme. The themes generally fit for both speeding and PUWD. The most frequent themes for both behaviours reflected their perceptions about the driver and perceptions about the consequences. Almost all participants described some motivation (n=4 skipped the question on PUWD and n=5 on speeding, primarily the same individuals). There was however variation in the detail of the motivation with some simply reporting, "it's dangerous", that was coded as a single theme and others reporting greater detail that was coded in multiple themes, e.g., "If it was raining or wet I would be encouraged more to speak up. If I, or other people in the car, were clearly uncomfortable I would say something. If they had been known for bad driving or previously gotten fined for speeding. But these would mainly apply if I knew them."



Note. Superscript reflects theme unique for Speed (S) or Mobile phone use (M) Order of subthemes alphabetical.

Figure 1. Overview of primary themes and subthemes

Benefits to road safety

The findings have implications for the prevention of speeding and PUWD while driving among young adults. We sought to understand how to draw in the passenger as a key actor in road safety, particularly through early adulthood where social norms have a clear role in road safety. We sought to understand specifically how they describe and understand their motivation to speak-up, which can potentially inform information campaigns to promote passenger engagement in road safety.

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Implications for policy and/or practice

Our recommendations support the continued promotion of a shared responsibility for road safety (e.g., as aligned with national policy recommendations; Australian Government, 2021). We identify the themes and example language that young people are using to describe their motivations. Understanding that young people feel motivated and the language that they use enables opportunity to inform road safety campaigns. Listening to young adults allows us to understand potential focus for campaigns and how peers can be an important lever in shifting young driver behaviours. The motivations allow an understanding of what to target (rather than just providing knowledge or instruction, to 'just speak up'). Campaigns can be built on the passengers' language and can help to normalise speaking up. The work provides real stories and helps inform the norms of safe passenger experience and potentially the way in which drivers can be 'responsible' by listening to feedback.

Conclusions

Young adult safety around the road continues to be a key public health concern. Enlisting peers as support for young adults offers a complementary approach to individual and other contextual approaches. Our findings highlight multiple motivations for speaking up that recognise the driving environment, relationship with the driver, emotional cues, and beliefs about consequences. Some young people simply described it as the 'right thing to do' and others offered example solutions from their previous experience of speaking up. Of note, a potential expansion of the study is to better understand how young adults may plan with one another to prevent any engagement in speeding or PUWD to further engage passengers and to better understand how these motivations play out in practice. Recognising the varied motivations however provides potentially valuable information for road safety initiatives that can directly target peers. Messaging that may empower young adult passengers to view protecting friends as necessary and impactful as well as potentially prompting intervention sooner.

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Legislated danger: how Queensland's transport legislation precludes a safe system

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Abstract
This study identifies structural mismatch between Queensland's road safety objectives and its governing legislation. While Professional Engineers legislation demands that an Engineer must ensure that their actions do not pose unreasonable risk to the community, articles of road transport legislation together codify safety as a variable to be traded for efficiency and "value for money". This permissive approach to management of risk represents an acute ethical and legal paradox for Engineers. In liability, and in the absence of any statutory duty, Queensland road authorities benefit from robust, cumulative liability protections, resulting in a paucity of contested proceedings. Without an evidentiary record that such proceedings might generate, institutional imperative to address systemic design deficiency or prioritise harm reduction is absent. Meaningful change demands reform to harmonise transport legislation with contemporary safety duties and professional ethics.

Introduction
Claes Tingvall's first rule of ethics for system designers is that "one must always do everything in one's power to prevent death or serious injury" (Tingvall, 1995). Tingvall's fifth rule is that "work must be based on the fact that the responsibility for every death or loss of health in the road transport system rests with the person responsible for the design of that system". Tingvall likely intended that usage of the term 'designer' be broader than narrow, but in terms of geometric road design and speed limit setting which are two pillars of the Eric Howard's Safe System framework (Howard, 2004), it is pertinent that Queensland Board of Professional Engineers' Code of Practice for Professional Engineers (2021) demands that a Registered Professional Engineer must (among other things):

- ensure actions, or inactions, do not pose an unreasonable risk to themselves or others; and
- ensure the health and safety of the public and the community is always considered.

Held together, the demands of Engineers regarding the health and safety of the public and the community pursuant to the Professional Engineers Act may be argued to be consistent with the Queensland Government's Road Safety Strategy (2022-2031) which includes an objective that "safety takes priority in all decision making" (Queensland Government, 2022).

In the context of the Australasian College of Road Safety Policy Position Statement - A New Systems Thinking Approach to Road Safety (2024) regulatory and governance frameworks are among the highest order construct that influence road transport outcomes. And yet discussion about how legislation may be influencing the management of risk in the road transport system is largely absent from the Australasian road safety context.

Conference theme
This study presents evidence that road danger is an inevitable consequence of in-force legislation that governs provision and operation of road transport infrastructure in Queensland. Meaningful change – the "paradigm shift" that Rechnitzer and Grzebieta (1999) called for 27 years ago – demands action in the shape of reform. This is a platform to agitate for that change.

Project description
Through review and reflection, this study explores the legislation and related imprimatur that together govern provision and operation of road transport infrastructure in Queensland with intent to articulate an understanding of the regulatory barriers to reduction of risk of harm to road users using the road transport network.

Findings
There are two pieces of primary legislation that govern the planning for, and provision and operation of, the road transport system in Queensland. These are:

- the Transport Infrastructure Act 1994; and
- the Transport Operations (Road Use Management) Act 1995.

Notably, both Acts predate any notion of Safe System. It cannot be argued that Safe System outcomes were in the

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contemplation of the legislators when these Acts were drafted.

At its simplest the Transport Infrastructure Act (TIA) establishes a regime for the strategic and administrative oversight, including procurement, of transport infrastructure while the Transport Operations (Road Use Management) Act (TORUM) is a framework for the management and regulation of roads and the people that use them. It can be seen from Table 1 that both articles of legislation operate cohesively to codify safety as a variable that may be traded off for efficiency gains, and that "the highest level of safety" is explicitly prohibited if it compromises mobility.

Table 1 Extracts from Queensland legislation

Act and section	Content
TIA s.2(2)	An objective of the Act is "*…to establish a regime under which (i) a system of roads of national and State significance can be effectively planned and efficiently managed; and (ii) influence can be exercised over the total road network in a way that contributes to overall transport efficiency; and (iii) account is taken of the need to provide adequate levels of safety, and community access to the road network…*".
TIA s.9	"*The chief executive must ensure that… the construction, maintenance and operation of all government supported transport infrastructure … is carried out in a way that… promotes the safe transport of persons and goods; and… is carried out in accordance with standards… designed, within overall transport objectives, to achieve efficiency, affordable quality and cost effectiveness.*"
TIA s.30	The carrying out of works or operation of roads by the Chief Executive must be conducted "*on a value for money basis*".
TORUM s.3(1)(b)	An overall objective of the Act is to "*provide for the effective and efficient management of road use in the State*" and to "*provide a scheme for managing the use of the State's roads that will … improve road safety and the environmental impact of road use in ways that contribute to overall transport effectiveness and efficiency…*".
TORUM s.4(1)	"*Although it may be possible to regulate to achieve the highest level of safety, doing so would ignore the impact of the regulation on the effectiveness and efficiency of road use.*"
TORUM s.4(2)	"*Therefore, this Act acknowledges the need to achieve an appropriate balance between safety, and the costs that regulation imposes on road users and the community.*"
TORUM s.13(2)(a)	"*The Minister and chief executive must endeavour to… achieve an appropriate balance between safety, and the costs that regulation imposes on road users and the community…*" and "*… promote efficiency, affordable quality and cost-effectiveness…*"

Clearly this is a misalignment with Safe System thinking. Meanwhile, "value for money" which is invoked in the TIA, implies economic rationalism wherein the financial burden associated with providing a benefit does not exceed the monetised benefit from the action. It can be established that this is a departure from other articles of legislation in which a statutory duty of care is established for duty holders, for example:

- Electrical Safety Act, 2002:
- Queensland Building and Construction Commission Act, 1991
- Rail Safety National Law (Queensland)
- Safety In Recreational Water Activities Act, 2011
- Transport Operations (Passenger Transport) Act, 1994
- Work Health and Safety Act, 2011.

In each case management of risk of harm is a non-negotiable responsibility and a duty holder must eliminate or otherwise minimise risk of harm "so far as is reasonably practicable" to a point that the marginal cost, time and trouble of mitigating a marginal disbenefit are in "gross disproportion" with the marginal disbenefit that might be mitigated: in simple summary a duty holder must be able to demonstrate that the risk is insignificant in relation to the burden of mitigating it (Bluff & Johnstone, 2005).

By comparison, common law negligence is less demanding, requiring no more than "judicious balance" between benefit and cost, not inconsistent with provisions for safety prescribed in the paired TIA and TORUM. But moreover, in terms of defensibility, Queensland road agencies' duty of care to road users is further narrowed further by the Civil Liability Act (2003), whose provisions are such that establishing negligence against a road authority for built-in design risk is exceptionally difficult.

First, the Civil Liability Act (CLA) establishes in law that "the general allocation of financial or other resources by [a road] authority is not open to challenge", which in practice permits a road authority to justify built-in design risk as an acceptable budgetary trade-off. Second, the CLA effectively shields a road authority from being found liable unless its actions are so unreasonable that no other agency would consider them acceptable. And third, the CLA establishes an almost insurmountably high evidentiary bar requiring that an injured plaintiff must prove that the road authority had

specific knowledge of the risk that eventuated to cause the harm, rather than a general awareness of the suboptimalities of a situation: itself paradoxically a barrier to a claimant insofar as a risk that is obvious to a road authority may also be held to be obvious to the road user.

Some legal scholars have argued that civil liability legislation more broadly provides an "unjustified level of immunity" for public authorities and may "represent an over-protective judicial attitude towards the protection of public funds", and argue for reform (de Jersey, 2007; Lunney, 2000; Ranaweera, 2021). Perversely, this legislative environment may stifle legal proceedings that could generate knowledge of design deficiencies as opportunities for systemic safety improvement rather than inconvenient legally protected externalities.

Benefits to road safety

This study is intended to be a catalyst for discussion of the need for legislative reform which is shown to be necessary in order to reach a Safe System end-state.

Implications for policy and/or practice

In the first instance, this study is expected to contribute a starting point for an ACRS policy position on legislative reform.

Conclusions

1. The TIA and TORUM predate any notion of the Safe System philosophy and expressly reject the highest level of safety. It cannot be argued that they might be interpreted to intend Safe System outcomes.
2. The absence of any statutory duty of care in the TIA and TORUM and moreover requirements contained therein to trade safety for efficiency and value for money outcomes are at odds with (i) the legislated engineering code of practice, (ii) other fields of human endeavor where a duty of care to the public is owed, and (iii) the state's own commitment to road safety. Such permissive management of public risk is both an ethical and a legal paradox for Engineers.
3. Queensland road authorities benefit from cumulative protections against liability. First, the absence of an affirmative statutory duty of care in the TIA and TORUM leaves road users dependent on common law duties. Such protection is then narrowed further by stringent provisions in the CLA. This legislative environment may stifle legal proceedings that could generate knowledge of design deficiencies as opportunities for systemic safety improvement rather than inconvenient legally protected externalities.

These points each represent arguments and avenues for legislation reform.

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Vulnerable road user safety at slip lanes using AI-video analytics

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Abstract
Left-turning slip lanes at signalised intersections improve traffic efficiency by allowing uninterrupted turning movements, but their safety implications for vulnerable road users (VRUs) remain insufficiently understood. This research provides a comprehensive safety assessment of slip lane configurations at signalised intersections, focusing on vehicle-VRU interactions. Using artificial intelligence (AI)-based video analytics, traffic conflicts and road user behaviour were examined across four slip lane configurations: raised crossings (wombat), zebra-controlled crossings, unmarked crossings, and two-aspect signal-controlled crossings. Video data were collected at 24 sites across Brisbane, Townsville, and Cairns, with six sites representing each configuration. Results indicate that wombat crossings slip lanes have the lowest conflict rates (7.4 conflicts per 1,000 VRUs), compared to zebra-controlled (28.8), and unmarked (43.5) slip lanes. Two-aspect signal crossings recorded a conflict rate of 14.2, with most conflicts attributable to pedestrian non-compliance with the crossing controls. These findings support evidence-based slip lane design guidance for road authorities.

Introduction
Slip lanes are a common design treatment at signalised intersections to channelise left-turning traffic. One of their main advantage lies in improving traffic flow by separating turning vehicles from through traffic and reducing intersection delay. However, despite these operational benefits, their safety implications remain insufficiently understood, particularly for Vulnerable Road Users (VRUs) such as pedestrians and cyclists. The geometric design of slip lanes may increase vehicle–VRU interactions by allowing higher turning speeds and reducing opportunities for safe yielding. In Queensland, between 2011 and 2020, 179 fatal and serious crashes were reported on slip lanes involving pedestrians and left-turning vehicles (QTMR, 2022). O'Brien et al. (2012) reported 195 pedestrian crashes involving left-turning vehicles in Melbourne, Victoria, between January 2004 and December 2008, of which 22% occurred at slip lanes. Among these, 3% occurred at signal-controlled slip lanes, 6% at unmarked slip lanes, and 13% at zebra-controlled slip lanes. These findings indicate that slip lanes pose substantial safety risks to VRUs, and these risks may vary depending on the type of slip lane treatment.

According to the Queensland Guide to Traffic Management, slip lanes at signalised intersections are provided in several forms depending on pedestrian control, including raised pedestrian crossings (i.e., wombat), pedestrian crossings with zebra control, unmarked crossings, and two-aspect traffic signal control (QTMR, 2025). Broadly, these treatments can be classified into signal-controlled and non-signal-controlled slip lanes, reflecting differences in how vehicle and VRU movements are regulated. Given that VRU protection levels vary substantially across these configurations, their safety performance is likely to differ. Despite this, there is limited literature examining the comparative safety implications of different slip lane configurations. In addition, most previous studies have relied on crash statistics, which provide a reactive assessment of safety because they are based on recorded crash outcomes. A more comprehensive understanding of slip lane safety requires a proactive approach that examines safety-critical interactions before crashes occur. Accordingly, further investigation is needed to understand how different slip lane configurations influence vehicle–VRU interactions at signalised intersections.

Conference theme
This paper aligns closely with the conference theme, "From Evidence to Action: Shaping a Brighter Future," by addressing a critical gap in the road safety literature through a comprehensive investigation of vulnerable road user (VRU) safety at slip lanes.

Method
This study investigates the safety performance of non-signal-controlled slip lane configurations, including: raised pedestrian crossings, zebra-controlled pedestrian crossings, and unmarked slip lanes. Two-aspect signal-controlled slip lanes were also examined separately because of their distinct control strategies. The dataset comprised six sites for each slip lane configuration. Video footage was collected from a total 24 slip lane sites in Brisbane, Cairns, and Townsville between February 2025 and October 2025 using two overhead cameras mounted at approximately 8 m. At each site, video recording was conducted continuously for one week, covering both weekdays and weekends, with approximately 12 hours of footage collected per day between 6:00 am and 6:00 pm. In total, 2,016 hours of video data were analysed. Raw video footage from the cameras was processed using AI-based video analytics to extract road user trajectories and

identify vehicle–VRU conflicts using Post-encroachment time (PET). The automated workflow for video data extraction is illustrated in Figure 1.

PET was initially used as the primary indicator for conflict identification, and all interactions with PET values below 4 s were extracted for comparison. To improve the identification of safety-critical events, an evasive action–based criterion was also applied, consistent with recent research suggesting that such measures can better reflect crash risk (Sahu et al., 2026; Singh & Haque, 2026). Specifically, a conflict was classified as a true conflict when either the vehicle or the VRU took evasive action to avoid a collision. In addition, traffic volumes of slip lane vehicles and VRUs were extracted for each site within the slip lane area.

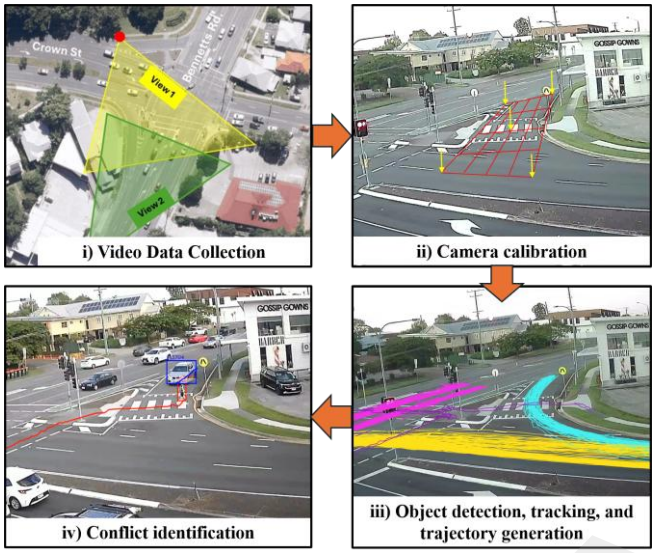

Figure 1. AI-based video analytics for data extraction and conflict identification

Results

Figure 2 presents a comparative analysis of slip lane configurations based on conflict frequency and conflict rate. The findings indicate that unmarked slip lanes experienced the highest number of conflicts and the highest conflict rate, with 43.5 conflicts per 1000 VRUs. The elevated conflict rate at unmarked slip lanes may be attributed to the absence of clearly defined pedestrian crossings and a greater likelihood of right-of-way violations by slip lane vehicles. Zebra-controlled slip lanes also recorded comparatively high conflict frequencies and rates (28.8). Although zebra markings provide a formal indication of pedestrian priority, the safety performance is influenced by driver yielding behaviour and vehicle approach speed. In contrast, raised pedestrian crossings were associated with relatively fewer conflicts and the lowest conflict rate (7.4) among the non-signal-controlled slip lane configurations. This lower conflict rate may be attributed to the raised crossing platform, which guide drivers to reduce speed before approaching the pedestrian crossing at slip lanes.

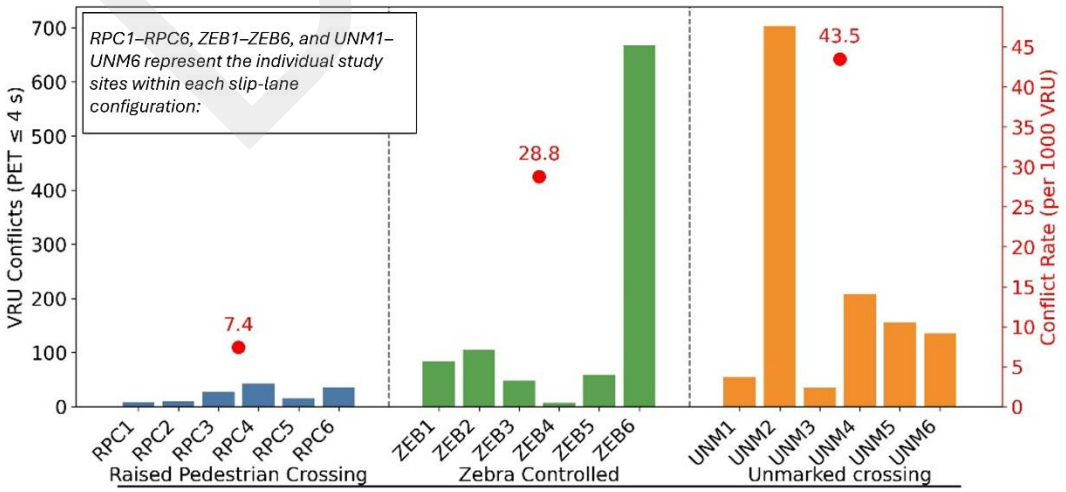

Figure 2. Site-wise VRU Conflicts and Configuration-level Conflict Rate

The conflict rate for two-aspect signalised crossings was 14.2 per 1000 VRUs. Interestingly, most conflicts at signal-controlled slip lanes involved pedestrians crossing without pressing the push button to activate the pedestrian phase. If pedestrians had activated the pedestrian phase and crossed during the designated interval, a greater degree of temporal

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separation between pedestrian and vehicle movements would likely have been achieved. These results indicate a likelihood of VRU non-compliance behaviour that played a significant role in the occurrence of conflicts at two-aspect signal-controlled slip lanes.

To better understand the mechanisms underlying the observed variation in conflict rates, the spatial distribution of conflicts was examined using conflict heatmaps (Figure 3). At unmarked crossings, conflict hotspots were more dispersed, with some concentrated near the slip lane entry and others throughout the crossing region. This indicates that, in the absence of a clearly defined crossing area, VRUs tend to cross the slip lane at multiple locations rather than at a single predictable point. Such dispersed crossing behaviour is likely to increase the frequency of safety-critical interactions, as drivers may be less able to anticipate VRU movements. At zebra-controlled slip lanes, conflicts were concentrated near the designated crossing area. Although the marked crossing provides clearer guidance for pedestrian movement, comparatively high vehicle approach speeds are likely to lead to more conflicts. In contrast, at locations with raised pedestrian crossings, the concentration of conflicts was comparatively lower and more localised around the crossing platform. The reduced intensity of conflict hotspots may be attributed to the traffic-calming effect of the raised crossing, which encourages drivers to reduce their approach speed and increases driver awareness of pedestrian presence. For two-aspect signal-controlled slip lanes, a distinct spatial pattern was observed, with conflicts not concentrated solely at the designated crossing but distributed across the entire slip lane area. This finding suggests that, despite signal control, VRUs cross at multiple locations, indicating potential VRU non-compliance with the signal, possibly due signal delays.

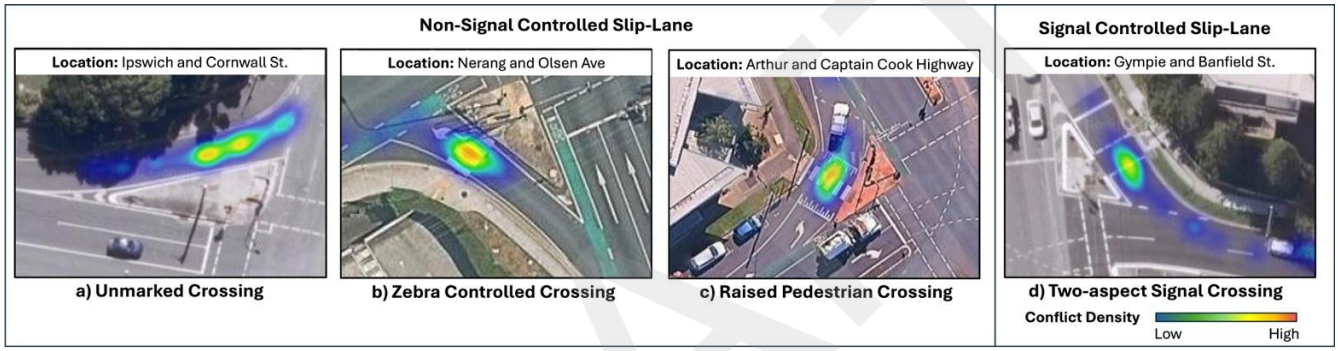

Figure 3. Comparative analysis of the spatial distribution of conflicts among the slip lane configurations

Conclusions

This study aims to undertake a comprehensive safety analysis of slip lane configurations using AI-based video analytics. The findings indicate that wombat crossing slip lanes have the lowest conflict rates, with 7.4 conflicts per 1,000 VRUs, compared to zebra controlled (28.8) and unmarked slip lanes (43.5). Additionally, conflicts at slip lanes with two-aspect signals were found to be largely associated with pedestrians not using the push-button facilities. The spatial distribution of conflicts further highlights that conflicts were more dispersed at unmarked crossing suggesting a broader spread of vehicle–VRU interaction risk across the slip lane area. A similar pattern was observed at two-aspect signal crossings, where conflicts were also dispersed around the slip lane, indicating possible pedestrian non-compliance with the designated control facilities. Overall, these findings indicate that wombat crossings deliver superior safety performance than other slip lane configurations and these findings contribute to evidence-based decision-making for safer slip lane planning and design. While the findings provide valuable insights within the Australian context, future studies should investigate whether these findings hold in other countries and contexts.

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Heavy vehicle and young driver interactions: a simulator study

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Abstract
Heavy vehicles are involved in a high number of multi-vehicle road crashes each year and are more than twice as likely to be involved in a fatal crash compared to a crash resulting in a hospitalised casualty. This study examined 96 light-vehicle drivers during simulated overtaking manoeuvres involving heavy vehicles on high-speed rural roads. Participants completed three scenarios varying in traffic density, while eye-tracking captured visual sampling of the oncoming lane and mirrors. Risky overtaking behaviours were common, with no completed overtakes meeting all defined safety thresholds, and more than half of overtaking drivers exceeding speed limits or merging with inadequate clearance. Provisional drivers showed the highest rates of unsafe overtaking and inconsistent lane checking was common. These results demonstrate gaps in hazard perception, understanding of heavy vehicle dynamics, and safe overtaking education. This provides evidence to inform improvements to novice driver licensing, training and education programs.

Background
Heavy vehicles are involved in numerous multi-vehicle road crashes each year (Bureau of Infrastructure and Transport Research Economics, 2023). During the period 2018 to 2024, heavy vehicles were involved in approximately 17.5% of fatalities and 8.4% of hospitalised casualties in Queensland. In this same period, heavy vehicles involved in multi-vehicle fatal crashes were deemed at-fault in only 23.7% of these crashes. Other road users were at-fault in 70.7% of these multi-vehicle crashes. Post COVID-19, the observed trend is that the proportion of heavy vehicles deemed at-fault in multi-vehicle fatal crashes in Queensland has been slowly declining (from 26.5% in 2020 to 15.6% in 2024) while the reverse has been observed for other road users (64.7% in 2020 to 81.3% in 2024). Following a 2023 roundtable involving industry government and other road safety stakeholders, a government transport agency engaged an independent team of university road safety experts to investigate young novice drivers' interactions with heavy vehicles. Concerns raised by industry was the driving behaviour of other road users around heavy vehicles, and in particular, drivers displaying P-plates. This project is using naturalistic observations using video data/dashcam footage from inside the cabin of heavy freight vehicles, along with laboratory-based driving simulations, to explore the driving interactions between young novice drivers and heavy vehicles.

Research indicates risk is compounded in young driver and heavy vehicle interactions by three underlying factors. These include underdeveloped neurocognitive maturity, a lack of driving experience and hazard perception, and a propensity for engaging in risky driving behaviors (Freire et al., 2021). The National Heavy Vehicle Regulator (2022) found that the majority (78%) were unable to identify the correct stopping distance for a prime mover semi-trailer truck, and less than half (45%) knew that one lane either side of a truck should be kept free when it is turning. This low level of knowledge poses a significant issue for road safety. Furthermore, many learner driving training materials contain limited information relating to complex interactions with heavy vehicles. To address this gap, this project utilises a driving simulator to investigate the behaviour, visual attention, and decision making of drivers and in particular young novice drivers, when interacting with heavy vehicles across a range of road environment scenarios.

Conference theme
This project provides evidence-based insights into interactions between other road users around heavy vehicles, an area associated with significant and preventable road trauma. The partnership between government and academia strengthens the pathway from research into practice by informing policy, educational campaigns, and driver training, to reduce road trauma.

Method
A sample of 96 light-vehicle drivers consisting primarily of young novice drivers were recruited to undertake a series of simulated drives where they had interactions with heavy vehicles. Human Research Ethics approval was obtained for all phases of the project through Griffith University (GU Ref Nos. 2025/042 and 2025/264). Of the 96 participants, 35.4%

held open licences,[1] 50.0% held provisional licences (19.8% P1 licence and 30.2% P2 licence), and 14.6% held learner, international, or other licence types. In each scenario, participants drove behind a Heavy Vehicle travelling slightly below the speed limit on a 100km/h two-lane rural highway. The Heavy Vehicle was deliberately set to be slow enough to create mild frustration and incentive to overtake, without presenting an obvious obstruction. Each participant completed three ten-minute driving scenarios, corresponding to low, varied, and high density of oncoming traffic. These conditions were designed to manipulate the availability of overtaking opportunities and the degree of time pressure experienced by the driver. Scenario order was counterbalanced across participants. During the simulator task, participants wore mobile eye-tracking glasses to record visual attention and eye gaze behaviour before and during overtaking manoeuvres. Eye-tracking data were used to identify whether drivers visually observed the oncoming lane, the heavy vehicle, mirrors, and internal instrumentation at key decision points. In addition to simulator-derived behavioural data, participants completed a set of self-report measures capturing driving experience, licensure, and relevant background characteristics.

Results

Risky overtaking behaviour was common among drivers who chose to overtake, with 59.4% of overtaking drivers engaging in at least one risky manoeuvre across conditions. Risky overtakes were defined as exceeding the posted speed limit during overtaking, merging back in front of the heavy vehicle with insufficient stopping distance for the heavy vehicle, or initiating an overtake when the distance to the nearest oncoming vehicle fell below calculated safe overtaking margins. Safety margin thresholds were calculated using standard stopping distance required and time-to-collision principles at posted highway speeds. Insufficient clearance and limited distance to approaching vehicles were identified relative to these margins. Across all participants and conditions, a total of 322 overtaking manoeuvres were completed. When evaluated against the defined stopping-distance and time-to-collision criteria, no manoeuvre satisfied all safety thresholds simultaneously. The proportion of overtaking drivers engaging in at least one risky overtake was 43.7% in the Low traffic density condition, 38.5% in the Varied traffic density condition, and 26% in the High traffic density condition. Risky overtaking was therefore less frequent when overtaking opportunities were highly constrained. Collision events were rare (n = 9 across all participants and conditions) and are interpreted descriptively.

When examined by provisional stage, differences were observed within the provisional cohort. Across conditions, 72.4% of P2 licence drivers engaged in at least one risky overtake compared with 47.4% of P1 licence drivers and 64.7% of open licence drivers. In higher traffic density conditions, P2 licence drivers showed the highest rates of risky overtaking (34.5%) relative to P1 licence (21.1%) and open licence drivers (23.5%). This pattern is consistent with elevated overtaking risk at later provisional stages, particularly under increased traffic density. In the Varied traffic density condition, several self-reported driving-related risk traits were significantly positively associated with increased risky overtaking behaviour after controlling for age, gender, and driving experience. Higher levels of driving-related sensation seeking, anger expression while driving, self-reported risky and aggressive driving behaviour, and lower endorsement of rule-based driving norms were each significantly positively associated with increased frequency of risky overtakes when examined in separate regression models (standardised β range = .355 to .460, all $p < .001$). In the High traffic density condition, aggressive driving behaviour ($\beta = .37$, $p < .001$), driving-related sensation seeking ($\beta = .334$, $p < .001$), and anger expression while driving ($\beta = .225$, $p = .029$) were also associated with increased risky overtakes. In the Low traffic density condition, driving-related sensation seeking remained the only significant predictor of risky overtaking behaviour ($\beta = .281$, $p = .009$). Eye-tracking fixation coding indicated inconsistent visual sampling of the oncoming lane prior to overtaking. The proportion of completed overtakes preceded by a fixation to the oncoming lane was 55.2% in the Low traffic density condition, 38.9% in the High traffic density condition, and 15.4% in the Varied traffic density condition. This pattern aligns with the behavioural findings, with the lowest visual checking observed in the condition where individual differences in risky overtaking were most pronounced.

Benefits to road safety

This research provides empirical evidence on the human-factor mechanisms driving unsafe overtaking behaviours around heavy vehicles. The study found a substantial proportion of overtaking drivers exceeded the posted speed limit, accepted short distances to oncoming vehicles, or merged back in front of heavy vehicles with insufficient stopping distance allowed for the heavy vehicle. These behaviours suggest that drivers frequently underestimate the time and distance required to safely overtake heavy vehicles under different traffic conditions. The patterns observed in this study indicate that current driver education materials may not adequately address the practical implications of heavy vehicle stopping distances and overtaking dynamics. These patterns represent modifiable behavioural risks that can be targeted through licensing system reforms, scenario-based learner education modules, and public safety campaigns.

The results also show that individual differences in driving-related risk traits are associated with overtaking behaviour, particularly in traffic conditions that require judgement of available gaps. Drivers reporting higher levels of sensation seeking, anger expression, and risky driving tendencies were more likely to engage in reduced safety margins when

[1] In Queensland's graduated licensing system, drivers progress from learner to P1, P2, and then open licence stages. The standard young-driver pathway requires at least 1 year on a learner licence, 1 year on a P1 licence, and 2 years on a P2 licence before an open licence. P1/P2 drivers display red/green P-plates, respectively, and are subject to provisional restrictions, including zero-alcohol, mobile phone, passenger, high-powered vehicle, and demerit-point restrictions.

overtaking heavy vehicles. The eye-tracking findings indicate that overtaking decisions were frequently initiated without consistent visual sampling of the oncoming lane. This suggests that overtaking risk is influenced not only by traffic conditions, but also by how drivers assess and act on perceived opportunities. In addition, differences observed between P1 and P2 provisional licence holders suggest that engagement in risky overtaking may increase as drivers transition to later stages of independent driving. This highlights the importance of reinforcing safe overtaking practices throughout the provisional licensing pathway.

These findings indicate the need for more explicit, scenario-based guidance within learner and provisional driver education frameworks. Clear instruction on safe overtaking distances, appropriate merge spacing, and the risks associated with high-speed overtaking of heavy vehicles may help reduce unsafe interactions on high-speed roads.

Implications for policy and/or practice

The result of this research has direct benefits to road safety by informing education, training and licensing policy and strategies, particularly relating to young novice drivers and safety for interactions with heavy vehicles. Embedding explicit training on heavy vehicle interactions with learner and provisional driver education would help address critical knowledge gaps. Clearer guidance on safe overtaking distances, merge spacing, and the braking and stopping characteristics of heavy vehicles could strengthen novice drivers' understanding and promote safer decision making. Furthermore, the elevated rates of risky overtaking observed among provisional drivers indicate a need for targeted communication and education initiatives during this stage of independent driving. Campaigns that highlight heavy vehicle momentum, stopping distances, and the risks associated with accepting short overtaking gaps may help reduce unsafe behaviours, particularly on high-speed rural roads.

Conclusions

This study demonstrates that risky overtaking behaviours are common when drivers interact with heavy vehicles, including speeding, limited clearance when returning to the lane, and acceptance of short distances to oncoming traffic. These behaviours occur across traffic conditions and licence stages, with elevated rates observed among later provisional (P2 licence) drivers in higher traffic density conditions. Inconsistent visual checking of the oncoming lane further indicates that overtaking decisions are not always supported by systematic hazard assessment. The findings highlight the need for clearer, practical guidance within learner and provisional driver education frameworks on safe overtaking distances, visual checking practices, and heavy vehicle stopping requirements.

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Navigating policy reform: storytelling and the politics of road safety

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Abstract
Despite decades of strong evidence on effective road safety interventions, many reforms stall or fail to reach full implementation. This is rarely due to lack of technical knowledge. Instead, progress often slows where political priorities, public trust, institutional structures and risk appetite intersect. This interactive workshop explores how road safety professionals can translate technical evidence into compelling reform narratives that resonate with decision-makers, communities and system leaders. Drawing on practical experience from major Australian and New Zealand road safety reforms including action plans, automated enforcement programs and other initiatives the session introduces narrative-driven policy design and systems thinking as tools for advancing implementation. Participants will work through structured activities to identify barriers to reform, map political and institutional dynamics, and practice reframing evidence into narratives that align with public value and policy priorities. The workshop supports the conference theme *From Evidence to Action* by equipping participants with practical tools to move road safety initiatives from analysis to implementation.

Introduction
Road trauma remains one of the leading causes of preventable death and serious injury across Australasia (World Health Organization, 2023). Many road safety initiatives fail to advance not because of technical uncertainty, but because reforms occur within complex political and institutional environments. Policy decisions must navigate competing priorities, public perceptions, risk tolerance and electoral cycles (Austroads, 2025).

Research and policy experience increasingly highlight that successful reform requires more than evidence alone. It requires the ability to translate technical findings into narratives that connect road safety interventions to community wellbeing, fairness and public value using well established behaviour change approaches (Ajzen & Fishbein, 2010).

As described in recent policy work exploring storytelling and systems thinking in road safety reform, progress often depends on how effectively reform leaders build trust, align with political priorities and communicate the human impact of safety initiatives (Green et al., 2023).

Conference theme
The ARSC 2026 theme “From Evidence to Action: Shaping a Brighter Future” highlights the challenge of translating road safety knowledge into real-world change.

This workshop directly addresses that challenge by focusing on the implementation gap between evidence and policy action. Participants will explore how narrative framing, political awareness and systems thinking can help road safety leaders move initiatives from technical recommendation to durable policy reform.

The workshop aims to strengthen the capacity of practitioners, policy makers and researchers to influence decision-making environments and build sustained support for evidence-based road safety measures.

Facilitator: Claire Campbell
Claire Campbell is a road safety policy specialist with more than 20 years’ experience leading major reforms across Australian transport agencies. Her work spans strategy development, legislative reform, behaviour change programs and policy evaluation. Claire has played a key role in the design and implementation of major initiatives including Road Safety Action Plans, speed camera strategies and the world-first Mobile Phone Detection Camera Program. She has advised governments, senior executives and industry leaders on complex road safety reforms requiring alignment across policy, political and community contexts. Her work focuses on translating technical evidence into compelling narratives that support policy reform and build public legitimacy for change. Through Claire Campbell Consulting, she supports government agencies and industry organisations to strengthen road safety management, improve implementation capability and accelerate progress toward zero trauma.

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Claire is an experienced facilitator and speaker who regularly leads workshops on road safety reform, strategy, policy development and road safety management.

Workshop leader: Carlyn Muir

Carlyn Muir is Associate Director (Education) and Associate Professor (Research) at Monash University Accident Research Centre. With qualifications in psychology and public health, and holding Senior Fellowship for the Higher Education Academy (SFHEA), Carlyn leads MUARC's education portfolio, and is an experienced safety researcher. Carlyn leads a range of custom-designed safety science professional development courses for industry and government, including MUARC's reimagined Road Safety Management Leadership Program and the Graduate Certificate of Road Safety. These courses focus on evidence-based practice and influencing change in complex systems.

Interactive Workshop format

Format	Activity	Lead	Timing	Description
Presentation	Context setting	Facilitator	10 mins	Overview of the road safety implementation gap and the role of narrative, politics and institutional dynamics in shaping reform outcomes
Interactive	Icebreaker	All	5 mins	Participants briefly discuss at tables: "Which road safety reform has been hardest to implement and why?"
Interactive	Interactive activity 1	Workshop leader	15 mins	Two split group Group 1 map barriers to reform using a simple framework (political priorities, public trust, institutional dynamics, risk appetite). Group 2 uses set instructions around story development to define Vision Zero clarity
Presentation	Evidence to narrative	Facilitator	10 mins	Introduction to narrative-driven policy design and examples from Australian reforms.
Interactive	Interactive activity 2	Workshop leader	20 mins	Groups select a road safety intervention and practice reframing it as a narrative aligned with public value and political priorities.
Discussion	Share back	All	10 mins	Groups present key insights and narrative strategies.
Presentation	Conclusion	Facilitator	5 mins	Summary of practical tools participants can apply in their organisations.

Interactive Workshop outcomes and actions

Outcomes may include, but are not limited to:

- Participants develop practical strategies to translate road safety evidence into compelling reform narratives.
- Insights from participant discussions will be synthesised into a short publicly accessible summary report.
- Participants will be invited to opt-in to receive the summary and further resources on narrative-driven road safety reform.
- Key themes emerging from the workshop may inform future research or practitioner guidance on improving implementation of Safe System initiatives.

By capturing practitioner insights across jurisdictions, the workshop will contribute to broader discussions on how road safety professionals can accelerate the transition from evidence to action.

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Personal factors affecting truck drivers' fatigue

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Abstract
Truck drivers experience an elevated risk of being involved in a fatigue-related crash. Various workplace factors are known to increase their risk, including long working hours, irregular schedules, loading/unloading delays and limited access to suitable rest areas. Studies investigating personal factors affecting Australian truck drivers' fatigue-management and compliance behaviours, however, are lacking. Semi-structured interviews were conducted with Australian truck drivers and transport managers to determine how personal factors influence their intentions regarding fatigue management. The findings indicate that familial pressure, financial viability, and inflexible enforcement and its personal consequences may influence fatigue-related behaviours. It is argued that government, transport companies and industry peak bodies, managers, unions and truck drivers should work together to co-develop fatigue management strategies. This will support safer fatigue practices including the management of personal factors that affect compliance.

Background
The association between truck driver fatigue (TDF) and truck crashes is well reported in research literature (For example, Rudin-Brown and Filtness, 2023; Williamson et al., 2011). In Australia it is estimated that fatigue contributes to one in three fatal truck crashes (Centre for Accident Research and Road Safety – Queensland, 2015). To reduce TDF risks, most Australian states prescribe the number of hours truck drivers may work and the number of hours they must rest (Casey, Miles-Johnson and Stevens, 2024), but fatigue related truck crashes still occur. These laws are administered via Heavy Vehicle National Law (HVNL) and enforced by police and other agencies including the National Heavy Vehicle Regulator (NHVR). Earlier studies show that TDF management and compliance risks are exacerbated by workplace factors including inefficient organisational practices, traffic delays, loading and unloading delays, limited access to suitable rest-stops and commercial pressures for expedited delivery (For example, Casey, et al., 2024; Williamson and Friswell, 2013). Yet studies exploring personal influences on truck drivers' and transport managers' intentions regarding fatigue are lacking. This study took a qualitative approach involving semi-structured interviews with Australian truck drivers and transport managers (who oversight the transport of freight by road) to better understand the influence of personal factors on their intentions regarding TDF management and compliance.

Conference theme
In concert with the conference theme, this study provides empirical **evidence** regarding TDF management and compliance, explains personal contributing factors and how these influence the translational gap and identifies **actions** that are likely to enable better TDF management and compliance with TDF regulations.

Method
Semi-structured interviews were conducted with truck drivers (n = 36, including 6 women) and transport managers (n = 8) across a variety of Australian jurisdictions between June – December 2023. This process enabled examination of personal factors that may influence decisions regarding fatigue management and to explore issues likely to emerge during the process of enquiry (Robson and McCartan, 2016). Participants ages ranged from 24 to 76 years with an average age of 54 years. Industry experience ranged from 1 year to 55 years, with an average of 23 years. Interviews were conducted by telephone (n = 43) and video-conference (n = 1), with all interview data recorded and transcribed. The interview data was then analysed using Braun and Clarke's (2012) thematic analysis process. Ajzen's (2005) Theory of Planned Behaviour (TPB) was applied to examine personal factors that influence participants' TDF responses. This process included reading and re-reading the interview transcripts to develop initial codes in the context of the research questions and TPB. An iterative review process was then employed to determine the thematic saturation point, leading to the development of the final overarching themes.

Findings
Three themes and four sub-themes emerged from the analysis.

1) Personal Factors Influence TDF Risk and Compliance Behaviour
Most participants (28/44) discussed how before leaving home, family concerns and expectations influenced their TDF risk responses. For example, some participants spoke about their *"sleep quality"* being impacted when children or partners were sick or distressed. This meant they experienced pre-shift fatigue; *"I'm fatigued, I'm not right to drive, but I still showed up for work, I still started the truck and still drove out the gate"* (Rowan, truck driver, 49 years old). When this occurs, however, drivers remain compliant because the definition of *"rest"* only requires disengagement

from work involving a truck with a gross vehicle mass of greater than 12 tonnes *(Heavy Vehicle National Law 2013* (NSW). It does not mean that periods of *"recuperative rest"* (Williamson et al., 2011, p. 499) have occurred. TDF crash risk, therefore, is likely to be affected before they start work. Almost half of the participants (20/44) discussed how personal and job-related conflicts can strain relationships, increase estrangement and risk relationship/marriage breakdown. Notably, one third of participants (16/44) suggested that truck drivers often prioritise family or personal obligations over workplace compliance demands, which could include *"push[ing] hard to get where he needs to be to keep everything sweet"* (Dominic, driver, 27).

1a) Personal Financial Viability and Payment Methods Influence TDF Risk Behaviour
Multiple participants (17/44) spoke of how drivers' responses to TDF can be influenced by concerns about personal financial viability. This is significantly influenced by how drivers are paid. For drivers on *"incentive payments"* (Williamson and Friswell, 2013), delays arising from waiting to load or unload freight, as well as traffic hold-ups or taking rest breaks (for which they are not paid) could mean they are penalised financially if they miss subsequent loads. When personal financial concerns were discussed, participants indicated that drivers are more likely to breach TDF laws and *"do what they gotta do to put food on the table"* (John, driver, 37)

1b) Fatigue Risks for Owner-Drivers and Small Companies
Financial pressures and incentives were also discussed in the context of truck drivers working as owner-drivers (sole traders/contractors) using their own truck to move freight. Half the participants (22/44) talked about additional personal economic pressures owner-drivers face to maintain business viability. Eight participants expressed concerns that owner-drivers were more likely to prioritise financial returns over good TDF practice.

2) Inflexible Enforcement and Financial Impacts Affect Fatigue

Many participants (27/44) expressed concern about inflexible prescriptive TDF laws. It was perceived that they took a *"One size fits all"* approach (Gerard, driver, 70) and that the rules *"don't coincide with the human experience, which is individual to every person"* (Vicki, driver, 49). Several participants (14/44) believed compliance with prescribed work or rest requirements could, perversely, be detrimental to their ability to manage TDF. For example, if they were not fatigued when they were legally required to stop, they could not rest, but if they felt fatigue at a later point in their shift, they could not stop and rest due to diminishing available work hours.

Most participants (30/44) were concerned by the likelihood of receiving expensive fines or financial penalties for not taking prescribed rest. Some spoke about fines costing drivers *"the weeks' pay*" (Andrew, driver, 29), and the strain this places on personal relationships, because when a driver's income needs to be redirected from the household budget to pay a fine it *"reflect[s] back on the family, the innocent people"* (Kevin, driver, 67). Six participants spoke of how drivers who are fined are often distracted by worry regarding how to *"pay the bills"* (Peter, driver, 66), leaving them *"stressing while they're driving a 68-tonne truck"* (Kevin, driver, 67).

Participants also expressed concern over driver focused enforcement approaches and how this contributes to rest-related stress for drivers, *"Because the person at the coalface is the driver, and they're the ones who bear the brunt of it"* (Dominic, driver, 27). When chain of responsibility and rest compliance were discussed with managers, most (6/8) said that enforcement activity was rarely directed towards them. This led to one manager suggesting that managers are more likely to be influenced by *"that risk and reward thing"* rather than TDF laws, explaining that *"You send 10 trucks down the road overloaded and with tired drivers in them. How many are gonna get caught? Probably only if something goes wrong"* (Aaron, manager, 62).

3) Organisational Practices Affect TDF Risk

Most participants (40/44) discussed positive organisational practices that reduced their personal TDF risks. This included comprehensive company induction and training programs that enabled drivers to *"understand exactly where you stood"* (Matthew, driver, 60), because this knowledge empowered them to challenge their manager regarding fatigue compliance without risking job loss.25 participants identified flexible delivery as enabling better TDF management because they removed pressure on drivers if they were delayed. Some participants, however, spoke of positive organisational practices only being offered by larger companies, since small companies lack the human, physical and financial resources that can optimise rest and reduce TDF risk.

3a) Electronic Monitoring May Reduce TDF Risks
When discussing organisational practices such as the use of electronic monitors or electronic work diaries, over half of the participants (28/44) spoke supportively of their use, because they perceived that managers could monitor TDF in real time to support drivers. One driver appreciated that such monitoring could also *"hold the company to account"* (Tom, driver, 35) and empower them to resist pressure from managers to engage in non-compliant rest behaviours because such behaviour was more likely to be exposed.

3b) Fixed Roadside Monitoring Cameras Can Increase TDF Risk
Despite strong support for 'in-house' TDF monitoring practices, attitudes towards systems managed by enforcement organisations differed sharply, with 23 participants arguing against the use of the National Safety Camera Network (National Heavy Vehicle Regulator, n.d.). Critiques were linked to the mandatory continuous 7-hour rest breaks

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required within each 24 h period. For example, if a driver becomes fatigued and stops earlier within the 24-hour period to rest for several hours, camera data calculations (determining time and distance travelled) could show that insufficient time remained to take a 7 h continuous rest break within the 24 h period. This was thought to likely expose the driver to the risk of sanctions regarding non-compliance with TDF laws. Consequently, fatigued drivers may *"push themselves to get past these cameras to have a* [mandatory 7h continuous stationary] *rest on the other side, [which] is a dangerous thing"* (Oscar, driver, 59).

Benefits to road safety

The findings from this study benefit road safety knowledge by revealing how personal factors influence Australian truck drivers' and transport managers' fatigue management and compliance outcomes. It has identified seven items (below), actionable by governments and industry stakeholders, that will assist truck drivers, including owner-drivers or small operators, to better manage TDF and improve road safety outcomes.

Implications for policy and/or practice

This study provides empirical support for seven actionable items to improve TDF policy and practice. Specifically, it provides four new strategies aimed at positively influencing the decisions made by truck drivers and transport managers. This includes the need 1) for transport stakeholders to develop industry standard fatigue management systems, including those that account for personal factors likely to influence truck drivers' fatigue related behaviour, 2) to facilitate industry wide training programs for truck drivers families to better support drivers to maintain restorative rest and healthier lifestyles, 3) for governments to redefine the regulatory definition of *"rest"* to better facilitate restorative rest, and 4) for governments to play a lead role in financing and promoting industry standardised training and technologies with a focus on enabling small companies to access these resources. Importantly, it also supports three recommendations found in earlier studies regarding the need 5) for transport companies to adopt flexible scheduling to enable truck drivers to rest as required, 6) for the industry to reduce or prohibit the use of incentive payments and 7) for enforcement agencies to re-focus enforcement activities on parties in the chain of responsibility. These recommendations are likely to promote truck drivers' health and safety and reduce TDF-related road crash risks.

Conclusions

The findings from this study present new knowledge regarding personal factors that influence attitudes, subjective norms and perceived behavioural controls on how truck drivers respond to TDF. For example, the influence of key people in a truck drivers personal life are likely to strongly influence TDF risk-related behaviour. Seven actionable solutions that can support truck drivers in relation to TDF risk reduction are identified and articulated. Personal factors such as familial influences and personal financial viability are likely to be core elements that influence TDF compliance behaviour. Personal circumstances, therefore, are identified as a predictive factor in determining TDF-related behaviour. Providing necessary support such as holistic fatigue management/lifestyle training, flexible delivery schedules and TDF-related technologies can potentially assist truck drivers to better manage personal influences and foster more positive attitudes towards TDF management and compliance, thereby reducing the likelihood of TDF related risks and road crashes.

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Evidence driving road safety advancements for children with disabilities

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Abstract
Children with disabilities have a significantly higher injury risk in motor vehicle crashes compared with children without disabilities. In 2020, a national survey of health professionals involved in assessing and prescribing for the motor vehicle transport needs of children with disabilities and medical conditions identified critical gaps in knowledge and skills. In response, MACA developed specialist training and evidence-based information resources for health professionals and other stakeholders. To assess the impact of these initiatives on road safety practices, Curtin University conducted a national follow up survey in 2023. Statistical and descriptive analyses of repeat participants indicated increased confidence in knowledge and more frequent assessment of transport needs of children with disabilities. Respondents also reported fewer barriers, including lack of specialised knowledge, difficulties gaining equipment funding and unclear processes. These findings indicate improvements in professional capacity and practices supporting the safe transport of children with disabilities in motor vehicles.

Introduction
Road traffic crashes are a leading cause of death among children in Australia and globally (AIHW, 2024; WHO, 2023). Children with disabilities and medical conditions face an increased risk of injury or death during motor vehicle travel. Despite this elevated risk, children with disabilities have received little attention in road safety research compared with other populations (Downie et al., 2019).

Seatbelts and child restraints are highly effective measures for reducing injury and death in motor vehicle crashes. However, the full safety benefits of these systems are only realised when children are optimally restrained. This requires the use of a restraint that is appropriate for the child's size and its correct use in accordance with the manufacturer's instructions (Whyte et al., 2020).

Children with disabilities often require special consideration when travelling in motor vehicles and may not be able to use standard child restraint systems (Downie et al., 2019). Their needs may arise from physical differences such as impaired posture, muscle tone or involuntary movement. In addition, children with neurodevelopmental conditions may experience significant distress during vehicle travel due to psychological or sensory needs, which can lead to attempts to remove restraints or exit the vehicle while it is moving (Black et al., 2023; Plummer at al.,2012; Yonkman et al., 2013). For these children, specialised restraint systems may be required to improve both safety and comfort (Downie et al., 2019).

Allied health professionals play a key role in assessing and prescribing strategies, supports and/or restraint systems for children with disabilities and medical conditions in motor vehicles. These professionals assess the child's unique needs in the context of their family situation and the vehicles they travel in. This assessment informs recommendations that often include behavioural strategies and/or restraint systems to support safe and comfortable travel. Parents frequently rely on allied health professionals as a trusted source of information about safe transport (Black et al., 2023).

In 2020 a survey of Australian health professionals supporting the transport needs of children with disabilities and medical conditions found that many faced significant barriers and reported low confidence in addressing them (Black et al., 2024). For example, only 16 per cent of health professionals believed that they had considerable knowledge and skill in addressing the motor vehicle transport needs of children with disabilities and medical conditions (Black et al., 2024). Most health professionals (92%) reported challenges when recommending or prescribing car seating. Key challenges included limited training opportunities, insufficient specialised knowledge, and a lack of appropriate seating options (Black et al., 2024).

These challenges had implications for children's safety and participation. Nearly half of parents and guardians of children with disabilities (49%) reported that their child missed out on everyday activities due to their transport

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arrangements. Further, over half of parents reported their child had gotten out of their restraint while the vehicle was moving, and ten per cent reported their child had exited the vehicle into the road environment (Black et al., 2023).

These findings highlighted the need for professional training, improved resources and system-level support to improve the safe transport of children with disabilities and medical conditions. Mobility and Accessibility for Children and Adults Ltd (MACA) was established in 2019 to advance safe and equitable transport for children (under 16 years) with disabilities and medical conditions. In 2025, MACA expanded its remit to include adults with disabilities. MACA applies a systems approach aligned with Australia's National Road Safety Strategy to address barriers affecting safe motor vehicle transport for people with disabilities. Its activities include building sector capability, leading research to strengthen the evidence base, informing policy, standards, laws and supporting innovation.

To build sector capability, MACA developed national information resources and training courses for the key professionals supporting the motor vehicle transport needs of people with disabilities. MACA also established the Australian Safety Assessment Program (AuSAP), with funding from the Transport Accident Commission and in-kind support from NeuRA – Transurban Road Safety Centre, Transport for NSW Crashlab and Britax Childcare Pty Ltd. AuSAP assesses, and sled crash tests restraint systems used by people with disabilities and medical conditions. This work supports the development of evidence-based guidance and training to improve safety information allied health professionals, for families, equipment suppliers, funding agencies and government.

Study aims

The aim of this study was to examine the impact of MACA's initiatives on road safety practices in Australia relating to the transport of children with disabilities and medical conditions in motor vehicles. Specifically, the study aimed to:

- examine the current experiences and perspectives of health professionals and organisations
- identify changes in these experiences and perspectives since 2020; and
- explore the use and perceived helpfulness of MACA resources for health professionals and organisations supporting the safe transport of children with disabilities and medical conditions.

Conference theme

This paper aligns with the conference theme *From Evidence to Action: Shaping a Brighter Future*. It demonstrates how MACA has translated research on the transport needs of children with disabilities into practical action through cross-sector collaboration with the allied health sector, industry, government, and researchers. By building professional capability and providing evidence-based training and resources, MACA supports safer and more equitable transport for children with disabilities and contributes to systemic improvements in child occupant safety—helping to shape a brighter future.

Method

A national online survey was conducted in 2023 to examine experiences and practices related to the safe transport of children with disabilities and medical conditions in Australia. The survey replicated a 2020 instrument to enable comparison over time and was administered to health professionals, organisational representatives and caregivers involved in supporting the transport needs of these children. This paper reports findings from health professional respondents. The questionnaire included multiple-choice and Likert scale items examining demographics, assessment and prescription practices, knowledge and confidence, perceived barriers, and use of information resources. Additional questions explored awareness and use of resources developed by MACA. Participants were recruited through invitations to previous survey respondents and through disability organisations, professional networks and social media. Data was analysed using descriptive statistics and compared with 2020 survey results. Changes among repeat respondents were examined using appropriate statistical tests to identify significant differences over time.

Results

A total of 166 responses were included in the analysis (health professionals = 126; organisational representatives = 40), with 44% of health professionals participating in both the 2020 and 2023 surveys. Health professionals from all Australian states and territories were represented.

Compared with 2020, repeat respondents reported significant increases in confidence and knowledge in addressing the transport needs of children with disabilities and medical conditions. Health professionals were also significantly more likely to include transport needs in their initial assessments and to conduct regular reviews of children's needs. Respondents reported fewer barriers related to lack of specialised knowledge, training and unclear processes, although most professionals still experienced challenges when recommending or prescribing for transport.

System improvements were also observed. There was a significant reduction in wait times for special purpose child restraints, with typical wait times decreasing from 5-6 months to 3-4 months between surveys. Changes in prescribing practices were evident, with repeat participants significantly less likely to prescribe a harness and more likely to

recommend Australian Standard child restraints or booster seats. Repeat respondents also reported increased use of equipment suppliers to fit special purpose child restraints.

Awareness and use of MACA resources increased between surveys, and these resources were widely accessed and rated as helpful or very helpful by health professionals.

Benefits to road safety

The findings of this study highlight the importance of educational resources and training, such as those provided by MACA, in strengthening the knowledge and skills of health professionals who support the transport needs of children with disabilities and medical conditions. Improving professional capability has the potential to enhance safe transport practices and contribute to improved road safety outcomes for this high-risk group.

Implications for policy and/or practice

The findings highlight the importance of strengthening professional capability to support the safe transport of children with disabilities and medical conditions. Improved knowledge, confidence and assessment practices among health professionals suggest that targeted training and evidence-based resources can support safer transport decisions. Continued investment in professional training and evidence-based guidance may help embed safer transport practices and reduce injury risk for this vulnerable group.

Conclusions

This study indicates that progress has been made in supporting the safe transport of children with disabilities and medical conditions in Australia over the past four years. Improvements in professional confidence, assessment practices and access to resources suggest that targeted training and information initiatives may help strengthen road safety practice. However, ongoing challenges remain, highlighting the need for further research and continued collaborative efforts between regulators, researchers, health professionals, industry, policymakers and not for profits to enhance equitable road safety for children with disabilities and medical conditions.

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Driving down risk: a review of Queensland's Learner Driver Program

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Abstract
Young drivers remain disproportionately represented in serious crashes despite reductions following Queensland's Graduated Licensing System (GLS), first introduced in 2007, and regularly expanded and improved since its introduction. To address persistent risk, a review of the Learner Driver Program (LDP) has recently been undertaken. Using a mixed-methods approach, the review assessed five key components of the LDP: PrepL, PrepL-S, Hazard Perception Test (HPT), 100 hours supervised driving, and the Practical Driving Test (PDT). Findings confirm the LDP aligns with best practice and reduced risk. However, gaps in addressing accessibility, inclusivity, and competency development remain. The review also identified a need to incorporate a more comprehensive competency-based framework. The actions stemming from the review have formed part of the Queensland Road Safety Delivery Plan to shape a safer future for novice drivers.

Background
Young novice drivers are one of the most at-risk groups on the road. Research has shown a strong relationship between young novice drivers' developing cognitive functioning and high crash risk (Ehsani et al., 2020). Young drivers aged 17-24 in Queensland represent approximately 14% of licence holders but are involved in a quarter of fatal crashes, and more than 2,000 young drivers are hospitalised due to serious road crashes annually.

Queensland has a Graduated Licensing System (GLS) for learner and provisional drivers. Since the introduction of the GLS in 2007, there has been a reduction in the proportion of young drivers involved in crashes resulting in serious injury (Scott-Parker et al., 2011). The GLS has been continuously improving since its introduction and has regularly been evaluated, with the last independent evaluation being conducted by the University of New South Wales in 2017. Due to the introduction of the online Prep-L pre-learner course, the online PrepL-Supervisor course, and the change to the hazard perception test, it was timely to conduct another evaluation of the GLS.

At the same time as the current independent evaluation was being planned, in early 2023, a road safety roundtable was held as a result of the sharp increase in road fatalities in Queensland post-COVID-19. The aim of the roundtable was to bring government representatives, academics, road operators and user advocacy groups together to combat road trauma through new ideas. Due to the continued over-representation of young drivers on Queensland roads and in the crash data, this group was a focus area for the roundtable. From the 2023 roundtable, the planned evaluation was expanded to also evaluate the practical components of the learner driver experience in Queensland; the 100 hours supervised practical driving and the Practical Driving Test (PDT).

An expanded GLS review is being undertaken in two phases to evaluate the effectiveness the Queensland GLS initiatives in terms of their effects on young driver attitudes, behaviours, and road safety outcomes (such as crashes, and serious injuries and fatalities resulting from them). The current paper focuses on Phase One of the expanded GLS review – Learner Drivers. The learner phase is pivotal for acquiring skills and attitudes that determine safety during early independent driving. Queensland's Learner Driver Program (LDP) includes online learning (PrepL and PrepL-S), hazard perception screening (HPT), supervised practice (100 hours), and an on-road assessment (PDT). This phase of the GLS review, which has been completed, evaluated the effectiveness, accessibility, and equity of each component, and designed reforms to better prepare learners for independent driving.

The LDP review (henceforth 'the review') aimed to determine if further interventions can be made based on contemporary research evidence and technological advancements. As of the submission date of this abstract, the actions

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arising from this review, which form part of the Queensland Road Safety Delivery Plan, have not been made publicly available, however are expected to be before the conference.

Conference theme

This research provides robust evidence on the effectiveness of Queensland's Learner Driver Program (LDP) and identifies critical areas for improvement. The findings contribute to a deeper understanding of how evidence-based evaluations can inform actions for the development of safer and more inclusive road safety programs.

Method

The Department of Transport and Main Roads (TMR) engaged an independent external team led by road safety experts from Monash University Accident Research Centre (MUARC), and including experts from Griffith University and the University of Western Australia to undertake the review. The primary objective of the review was to evaluate each component of Queensland's LDP and determine whether these components are achieving their intended safety outcomes and aligning with the goals of the GLS. The review aimed to identify which elements of the LDP deliver measurable safety benefits and where gaps exist, using evidence to inform future improvements that enhance novice driver safety and reduce crash and infringement risk.

The review adopted a mixed methods approach consisting of:

- Systematic literature review and jurisdictional review of Learner Driver components and licensing systems.
- Consultation via interviews and focus group sessions with 61 stakeholder groups including learner driver mentors and representatives from government, industry, and advocacy groups.
- Three (3) online surveys with 678 parents/guardians (supervisors), 893 learner drivers, and 379 P1 (first year provisional) drivers.
- Statistical analysis of Queensland licensing, infringement and crash data to measure the impact of each GLS LDP component on crash and offending outcomes for learner, provisional, and open licence drivers.
- Collaborative co-design workshops with key stakeholder groups to inform the development of a new competency framework and action roadmap.

Findings

Findings from the evaluation confirmed that Queensland's current approach to the Learner Driver stage is fit for purpose, aligns with best practice, and provides a strong foundation for learners and their supervisors as they progress through the GLS (Foss, 2007). Notably, the crash risk for all novice driver licence classes reduced in the early years after the introduction of the GLS. The analysis also identified P2 (second and third year provisional) drivers had a higher crash and infringement risk than any other licensing phase. Specific insights were also identified across the GLS learner driver components.

PrepL (online learner course)

- Learners who complete PrepL had a 25% lower crash risk and a 35% lower infringement risk.
- There is an opportunity to improve access to PrepL (particularly for disadvantaged groups), enhanced content with more sophisticated data capture capabilities.

PrepL-S (online supervisor course)

- Supervision instruction is critical and resources to uplift supervisors (such as PrepL-S) play a crucial role in achieving better road safety outcomes and reducing 'driver behaviour transfer'.
- There is an opportunity to uplift content in PrepL-S to meet best practice adult learning requirements and provide targeted content to support supervisors.

Hazard Perception Test (HPT)

- Hazard perception plays an important role in road safety. There is an opportunity to improve and modernise the HPT to align with customer requirements and expectations, and best practice for this technology.

100 hours supervised driving

The findings from the literature review support previous research that a quantum and diversity of supervised experience are jointly important (Bates et al., 2010; Bates et al., 2014).

- Provisional driver crash risk per licenced driver was lower in jurisdictions with higher mandated learner hours, despite differences in licensure age and concession rules (such as passenger restrictions).
- Queensland's 100-hour requirement is consistent with best practice, but other states provide more support for accessing driver instruction or mentoring of learners (e.g. Victoria's L2P program).
- Young people said they feel 100 hours is the right amount of time to feel confident to drive on the road independently, consistent with findings from previous research (Bates et a., 2010; O'Brien et al., 2013).
- Learners who received professional instruction had a 23% lower crash risk during the early P1 phase and a lower infringement risk across all provisional licence phases.

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- Learners need experience across a wide range of driving environments. There is an opportunity to improve supervisor guidance on key competencies that must be achieved before sitting the PDT.
- Learners with inconsistent access to supervisors, such as young people in care, migrants, or those with no adult drivers in the household, were disproportionately disadvantaged in reaching the 100-hour requirement.
- Supervisors and examiners raised concerns about falsified logbook entries, suggesting the need for enhanced verification or feedback mechanisms. Both learner drivers and supervisors expressed the need for logbook functionality upgrades.

Practical Driving Test (PDT)

- P1 drivers who had an unsuccessful PDT attempt were slightly more likely to self-report having been involved in a crash (30%), compared to drivers who did not have an unsuccessful attempt (22%).
- Participants felt that the PDT placed more emphasis on technical driving than real-world readiness, with some examiners expressing concern about candidates passing despite driving safety reservations.
- The findings identified a need for increased diversity of driving environments for a more comprehensive PDT.
- There is an opportunity for a longer-term shift to competency-based assessment to determine physical and higher-order skills.

Benefits to road safety

The findings highlight the significant benefits of Queensland's Learner Driver Program for road safety. The program has contributed to a measurable reduction in crash and infringement risk among novice drivers, particularly during the high-risk P1 phase. Addressing barriers to accessibility and inclusivity has the potential to further extend these benefits to underrepresented groups, creating a more equitable and effective road safety system.

Conclusions and future considerations

The review provides robust evidence on the effectiveness of Queensland's LDP in delivering measurable safety benefits. However, opportunities for system level and competency-based improvements were identified. By addressing gaps in accessibility, inclusivity, and competency development, the findings deepen understanding of how enhanced learner driver programs can better reduce road trauma. Overall, the study highlights the critical role of evidence-based evaluation in shaping safer and more equitable road safety initiatives.

The findings from this project also provided insights into the behaviours of provisional drivers. Notably, Queensland's crash risk for provisional drivers was higher than in other jurisdictions with more quality assurance mechanisms (e.g., Victoria and NSW), such as more stringent learner hour requirements or more coaching tools available. Additionally, P2 drivers had a higher crash and infringement risk than any other licensing phase, which differs from previous research where P1 drivers were most at risk (Senserrick et al., 2021). These findings will be further explored in Phase Two of the GLS Review – Provisional Drivers, which is currently underway.

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Laundering not always washing away protection of motorcycle protective garments

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Abstract
Motorcycle protective clothing plays a crucial role in enhancing rider safety. However, routine laundering may affect its protective performance over time. This study investigated the effects of laundering on the protective properties of motorcycle garments. Impact abrasion resistance, impact energy attenuation, and seam strength, were evaluated pre and post laundering following the MotoCAP test protocol. The common myth that Kevlar® may not be washed was dispelled, with improved abrasion performance observed for all garments containing para-aramid fibres after laundering. In contrast, laundering reduced abrasion resistance and seam strength of the woven synthetic textile garments. All impact protectors/armour exhibited deterioration after washing. These findings provide practical guidance for the riding community on garment care practices to help optimise protective functionality.

Introduction
Motorcycles play an important role in the lives of many Australians, serving both as a source of recreation and a practical, cost-effective mode of transportation. For many riders, motorcycles form part of daily mobility. According to the statistical reports from the Bureau of Infrastructure and Transport Research Economics (BITRE, 2022, 2023), motorcycles account for approximately 4.5% of all registered vehicles in Australia.

Despite their benefits, motorcycles pose significant safety risks. Motorcyclists are overrepresented in road trauma statistics, accounting for a disproportionate number of fatalities and injuries. In 2022, Australia recorded 1,194 road crash deaths, a 5.8% increase from the previous year (BITRE, 2022). The economic burden of road trauma was estimated at $27 billion in 2012, with motorcyclists contributing approximately one-fifth of this cost. In Victoria, motorcycles represent only 3.8% of registered vehicles but account for 19% of all injury and fatality compensation claims in Victoria (TAC, 2023). Similarly, in New Zealand, motorcycles comprise 3.6% of registered vehicles yet contribute to 11% of road fatalities. These statistics highlight the urgent need for improved rider safety measures.

One crucial factor in mitigating motorcycle crash injuries is the use of protective clothing. Previous research has demonstrated that high-quality protective garments significantly reduce injury severity in the event of a crash (de Rome et al., 2011). However, several factors may influence the long-term effectiveness of protective gear. Australia's warm climate is one such challenge, as heat and discomfort can discourage riders from consistently wearing protective clothing (de Rome, 2019). In addition, regular laundering is necessary to maintain hygiene, but washing and drying process may degrade the protective properties of garments over time.

Therefore, this study investigates the effects of instructed laundering on the key protective properties of motorcycle garments, aiming to provide evidence-based recommendations for maintaining the performance and longevity of motorcycle protective clothing.

Conference theme
The motorcycle clothing space is full of misinformation and myths. This research uses ***Evidence*** gathered from research to take ***Action*** in dispelling these myths. By providing evidence-based knowledge to riders there is an opportunity in ***Shaping a Brighter Future*** for all motorcyclists.

Method
Seven motorcycle protective garments, including a hoody, shirt, jacket, three pairs of denim pants, and a pair of women's leggings, were subjected to 20 washing and drying cycles following the care label instructions provided on each garment. Laundering was conducted at temperatures below 30°C with garments line-dred in shaded conditions. Pre and post-laundering, the garments were tested for impact abrasion resistance, seam strength, and impact protection in accordance with the MotoCAP test protocol (Liz de Rome, 2024). The results were compared with those obtained from the garments in their new, unwashed garments.

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Results

Figure 1a presents the abrasion resistance results for Zone 1 and 2 areas before and after laundering. The location of Zone 1 and 2 within a garment are illustrated in Figure 1b. Overall, no significant changes in abrasion resistance were observed for most garments following 20 cold wash and line-dry cycles. The exceptions were the textile jacket, and U-denim pants. The textile jacket exhibited a substantial 80% reduction in abrasion resistance after laundering. This decline was attributed to the degradation of a cushioning material contained in the Zone 1 area. The U-denim pants showed a 45% reduction in the abrasion time; however, this change resulted from reduced variability in measurement as the abrasion time remained at the lower end of the unwashed time distribution.

In contrast, the P-denim pants, riding shirt and stretch leggings demonstrated increases in abrasion resistance of 44%, 31% and 64%, respectively, after laundering. Each of these garments featured Kevlar® (para-aramid) fabric linings. Laundering likely increased the fibre entanglement within linings caused by laundering enhanced their resistance to abrasion (Dolez et al., 2020). This was contrary to the myth circulation in the riding community that laundering Kevlar®- reinforced pants reduces their protective performance.

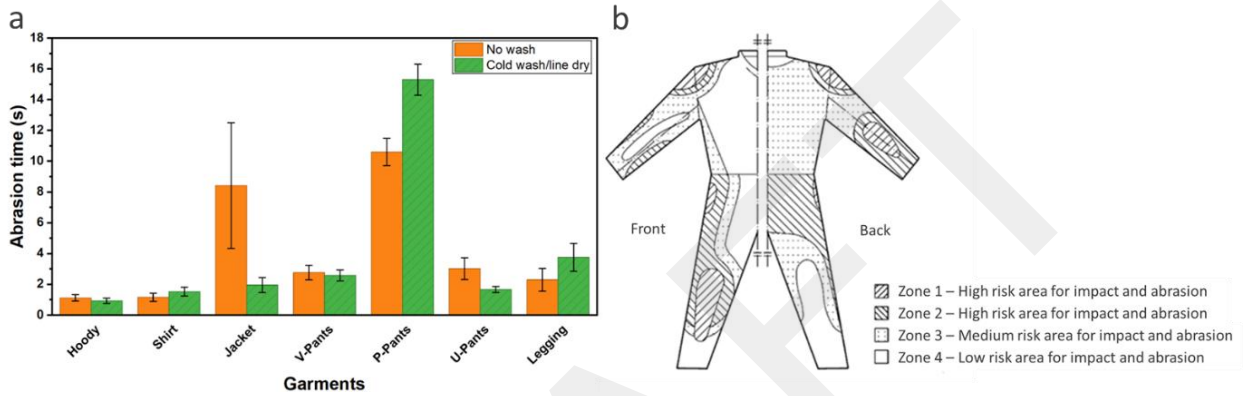

Figure 1 (a) Zone 1 and 2 abrasion times for (N) before laundering and (C) after cold wash and (b) zone diagram showing Zone 1 and 2 areas.

Seam strength exhibited trends similar to those observed for abrasion resistance (Figure 2). Seam strength in woven synthetic textile garments deteriorated following washing, decreasing by 61% for the riding shirt and 33% for the textile jacket. For the riding shirt, this reduction was attributed to seam puckering caused by fabric distortion during washing and drying (Yildiz & Pamuk, 2022). In the textile jacket, the reduction was associated with a breakdown of the polyurethane binder coating on the inner fabric surface, which allowed seam slippage after exposure to water. In contrast, seam strength in the leggings improved slightly, likely due to the properties of the sewing thread. Previous studies have observed increased seam strength after laundering for certain sewing thread types (Babu et al., 2022).

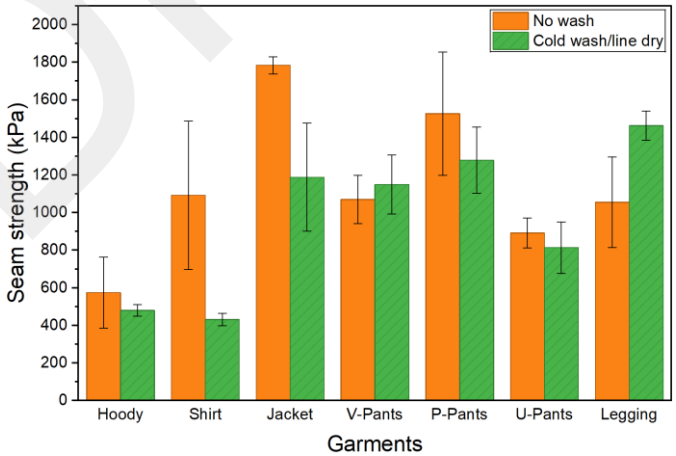

Figure 2 Comparison of seam strength of each selected garments in high-risk areas before and after twenty washing according to the care label instructions.

Figure 3 illustrates the effect of cold washing and air drying on the impact attenuation of the shoulder, elbow, hip, and knee armour. The transmitted force of all armour pieces increased after laundering, indicating a reduction in their energy absorption capacity. This suggests that laundering compromised the protective performance of the armour. All armour tested contained a polyurethane base material which is susceptible to hydrolytic degradation when exposed to water. Based on these findings, it is recommended that impact protectors be removed from garments before laundering.

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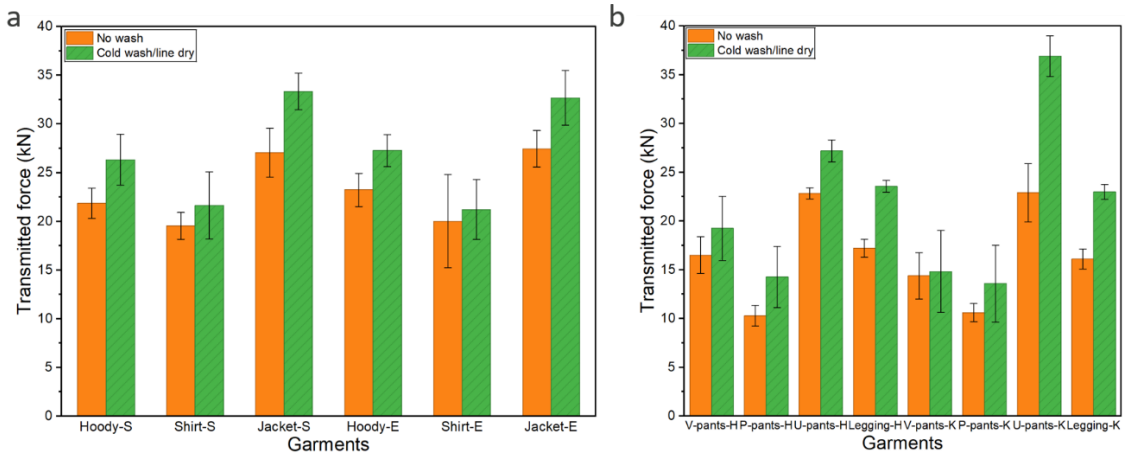

Figure 3 Comparison of impact resistance in armours of selected top garments before and after washing. Left, shoulder and elbow armours; right, hip and knee armours

Benefits to road safety

This research helps to empower riders with knowledge on the impacts of washing their protective motorcycle gear. It will result in gear that looks, feels and protects better over a longer period of time.

Implications for policy and/or practice

- Key rider messages that can be communicated to riders by road safety groups:
- Follow the care instructions when laundering motorcycle protective garments.
- Kevlar® and para-aramid lined garments may improve in abrasion protection after laundering.
- Minimise laundering garments made from woven synthetic materials due to seam strength loses.
- Impact protectors must be removed from gear before laundering as their protection will reduce due to exposure to water. If cleaning is necessary, wipe with a damp cloth instead of submerging in water.

Conclusions

This study highlights the impact of laundering on the key protective properties of motorcycle garments, including abrasion resistance, seam strength, and impact protection. Laundering following the care instructions had minimal degradation of protective properties for most of the garments evaluated. Laundering improved the abrasion resistance of all Kevlar® lined garments included in this work. Seam strength in woven synthetic textile garments deteriorated after washing. All impact protectors laundered in this research reduced protective performance. Clear guidance and stronger messaging are needed to ensure riders remove impact protecting armour before washing their gear.

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DRAFT

Amplifying children's voices in road safety to advocate and protect

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Abstract
This paper examines three project-based collaborations undertaken by *Kids and Traffic*, the NSW Early Childhood Road Safety Education Program, to explore the role of child voice in early childhood road safety education. Children participated in identifying local road safety risks, shaping communication strategies, and influencing adult behaviours within their communities. The projects demonstrate that child-centred, participatory approaches can effectively strengthen family engagement and enhance protective practices when balanced with adults' responsibility to protect children. These findings highlight a practical model for moving from evidence to action by positioning young children as active contributors to safer environments while maintaining essential adult accountability. The outcomes have implications for further embedding child-voice pedagogy within *Kids and Traffic* professional development and broader road safety education frameworks.

Background
Transport related injuries continue to be a leading cause of death in children under 14 years of age in Australia (Australian Institute of Health and Welfare, 2024). In NSW over the past three years, more than 800 children have been seriously injured in road crashes and a further 53 have died (Transport for NSW, 2026). The NSW Government's Road Safety Education Program is the leading model of support for educating children, young people and their families about road safety. The Program is an enduring, shared-governance collaboration between Transport for NSW, NSW Department of Education, Independent Schools NSW, Catholic Schools NSW, and *Kids and Traffic*, the NSW Early Childhood Road Safety Education Program at Macquarie University. Transport for NSW partners with the early childhood and school education sectors to ensure that developmentally appropriate road safety education is included in teaching programs, organisational policies and procedures, and in partnerships with families.

Transport's Road Safety Education Program is underpinned by sound educational philosophy, recognising that children and young people have strengths and interests that can be nurtured to improve their own and other's wellbeing (NSW Department of Education, 2026). Harnessing the voices of children and young people to protect and promote their own safety has been shown to be an engaging and effective strategy for minimising risk and affecting behaviour change (Holquist et al., 2023). Whilst a broad body of evidence and a strong rationale exist for including the voices of our youngest children in matters that impact them (Martinez Sainz et al., 2024), a careful balance must be struck between educators and families fostering children's agency, and crucially, protecting them from harm.

The *Kids and Traffic* Program recognises the conflict that may arise as educators navigate this balance in their practice when embedding road safety education into their everyday programs. Through *Kids and Traffic* professional development workshops for educators, educational resources, and consultancy, the Program supports collaborative grassroots action to prevent child road trauma via high quality early childhood pedagogy. In 2025, the *Kids and Traffic* Program reached more than 4500 early childhood services across NSW.

Conference theme
This paper aligns with the conference theme *From Evidence to Action: Shaping a Brighter Future* as it is informed by both educational theory supporting child voice in pedagogy, along with child development theory, recognising young children do not yet have the skills and understandings they need to keep themselves safe independently. The evidence is used to shape an approach to early childhood road safety education that positions children as active contributors, with agency to influence the road safety practices of the adults in their lives. Instilling safe attitudes and behaviours in our youngest citizens is not only impactful in the present but has potential for shaping positive safety outcomes into the future.

Project description
Kids and Traffic Consultants work closely with early education and care services in NSW to support the delivery of developmentally appropriate road safety education to young children and their families. For services that regularly engage in *Kids and Traffic* professional development workshops, opportunities often arise for deeper collaboration. This paper explores three distinct project-based collaborations with a focus on child voice that occurred between 2022 and 2026.

Service one is a long day and outside of school hours care service catering to 174 children in the lower Hunter Valley. The service philosophy emphasises recognising children as confident and involved learners. A group of preschool children (three to five years olds) volunteered to join the 'Collab Crew'. The intention of establishing the group was for children to voice their thoughts, concerns and interests in relation to the service.

Children identified the service's busy car park as an area of concern. Children considered what their families needed to remember when using the car park which led to the children determining a list of 'car park rules' for families to follow at arrival and departure times. Children's words and drawings formed the basis for 'car park rules' posters that were displayed to remind families of their responsibilities to keep children safe (see figure 1).

Service two is a long day care service catering for 43 children in the Wollongong area. The service is situated in a recreation space, surrounded by two playing fields and a car park it shares with the local football club. The area is a hub for community activity, particularly in the afternoons when children and young people attend football training or use the space for other activities including riding e-bikes and e-scooters. Service management, educators and families were alarmed by some of the unsafe behaviours observed in these shared spaces, particularly the car park. The service reassessed its arrival and departure procedures and worked with the football club to actively promote safe practices to emphasise adult responsibility for the safety of young children.

Preschool aged children attending the service were actively engaged in identifying and assessing risks in the car park and establishing strategies for communicating safe behaviours to all stakeholders (see figure 2). Children then created a series of visuals to promote and advocate for safe behaviours.

Service three is a long day care service catering for 56 children located in north-western Sydney. This service is a *Kids and Traffic* demonstration centre, where management and educators work closely with *Kids and Traffic* Consultants to create and trial road safety educational experiences and strategies for inclusion in Program materials. Children at this service connect with their local community through regular excursions. Children in the preschool room actively participate in planning and preparing for excursions.

Children's voices form part of the risk assessment process for every excursion with children actively involved in establishing risk mitigations (see figure 3). Family engagement in, and attendance on excursions has been sought directly from children to improve adult to child ratios to increase supervision, minimise risk and enhance the quality of interactions.

Figure 1. Car park rules poster
Source: *Kids and Traffic*

Figure 2. Car park assessment

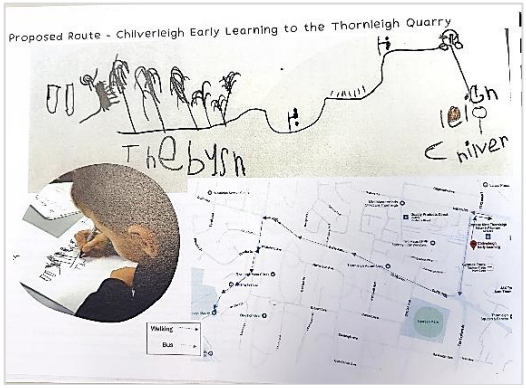

Figure 3. Excursion risk assessment

Findings

Staff from each service reported benefits from activating children's involvement in road safety discussions, risk assessment, decision making and communication strategies. Service's reported increased engagement with families around the identified road safety issues. Children's agency and participation in communicating road safety messages to their families highlighted the importance of relationships and children's unique position in positively influencing the behaviours of the adults in their lives. Staff observed children confidently verbally reinforcing safe behaviours with adults such as hand holding, helmet wearing and restraint use with the support of the visuals they had created to display. Children were also observed reminding their peers of road safety behaviours at arrival and departure times and while on excursions (service three).

Feedback and reflection on children's and families' engagement was provided by educators across the three services, supporting the approach to amplify children's voices to increase awareness of developmentally appropriate road safety

messages. Services reported short term improvements in the protective practices of adults, however, longer term behaviour change was not tracked. For services one and three, the publishing of multiple social media communications to families using the visuals created by children extended the focus on road safety practices, particularly hand holding at arrival and departure times. Additionally, families of children at service three were surveyed to assess their understanding of the service's road safety program and its impact on their own and their children's behaviour. Families reported the increased exposure to road safety messages and children's agency in learning supported them to reinforce these safe behaviours with their children. Some families reported their children were more aware of what to do to keep themselves safe, however, they did not qualify whether independently or with the adult supervision that is required to protect young children.

Benefits to road safety

Road safety outcomes for young children can be enhanced by embedding developmentally appropriate, child-centred pedagogical approaches that recognise their capacity to identify risks and communicate safety expectations within their everyday environments. This approach can strengthen families' protective behaviours by leveraging children's influence on adult practices. The collaborative, participatory processes fostered between services, children and families can contribute to sustained community awareness and shared responsibility towards children's safety.

Implications for policy and/or practice

These collaborations show promise for formally embedding children's participatory roles in risk assessment and road safety communication to increase family engagement. By demonstrating that children's agency can meaningfully influence adult behaviour, the findings support inclusion of these approaches in *Kids and Traffic* professional development content. Caution is required, however, to ensure children's agency in learning and communicating about road safety does not undermine the responsibility of the adults in their lives to protect them from road trauma.

Conclusions

The findings indicate that developmentally appropriate, child-centred pedagogical approaches can effectively enhance young children's participation in road safety education while simultaneously strengthening families' protective practices through increased engagement. These collaborations demonstrate the value of recognising children as capable contributors to shared safety responsibilities, provided that their agency is balanced with the ongoing obligation of adults to ensure children's protection from road trauma. Future work may systematically examine the long-term impact of these participatory approaches and explore their increasing integration into broader *Kids and Traffic* professional development and policy frameworks.

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DRAFT

Mobile Point-to-Point and Multi-Function Enforcement: evidence from Western Australia's pilot

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Abstract
Traditional "spot" enforcement often triggers a "kangaroo effect" where drivers slow for a visible camera before accelerating again, failing to manage speed consistently across corridors. This paper presents lessons learned from Western Australia's deployment of Mobile Point-to-Point (MP2P) enforcement, drawing on findings from the 2021-2023 Safety Camera Trial and the subsequent transition to live enforcement from late 2025. Across 170 trial sites and 7,916,963 detections, the data reveals persistent non-compliance, including a 17.17% spot speeding rate in 70 km/h school zones during school hours. The WA deployment integrates AI-based Automatic Number Plate Recognition (ANPR) with simultaneous detection of mobile phone and seatbelt non-compliance, aligning with 2025 Austroads best practice guidance. These findings demonstrate that corridor-wide, multi-function enforcement can deliver sustained, network-wide behavioural change in ways that traditional spot enforcement cannot.

Background
Western Australia recorded 188 deaths in the 12 months ending January 2026 (BITRE, n.d.). The state's road trauma is increasingly characterised by a stark metropolitan-regional disparity (AAA, 2023). In 2023, regional roads in Western Australia accounted for 89 deaths, representing a disproportionate difference to the 69 deaths recorded in metropolitan areas (Government of Western Australia, 2025a). Evidence confirms that regional road trauma is inextricably linked to speed, as almost half of all fatalities in 2024 occurred on roads with speed limits of 100 km/h or more, the vast majority of which were in regional and remote settings (Government of Western Australia, 2025b).

To transform evidence into action, it is essential to shift the enforcement paradigm toward corridor-wide management that accounts for the physics of speed. Kinetic energy increases with the square of velocity, meaning even small speed increases result in substantially higher energy transfers during a collision, a relationship formalised in Nilsson's Power Model, which demonstrates that fatality risk scales approximately with the fourth power of the speed ratio (Nilsson, 2004). For pedestrians, this threshold effect is stark: survival chances reduce from approximately 90% at an impact speed of 30 km/h to less than 20% at 50 km/h (Rosen & Sander, 2009; WHO, 2023). Traditional enforcement relies heavily on police patrols or static spot speed cameras, which are often insufficient for vast regional corridors where the "kangaroo effect" drivers slowing down only for a visible camera before accelerating again, prevents consistent speed management across long distances (D'Elia, 2025).

Conference theme
This research responds to the ARSC 2026 theme *From Evidence to Action: Shaping a Brighter Future* by bridging the gap between speeding data and scalable, real-world safety interventions. The project leverages the evidence gathered from the Western Australia Safety Camera Trial (July 2021 to February 2023). This data reveals a previously under-addressed landscape of high-risk behaviours, including significant rates of simultaneous speeding and distraction within regional corridors and school zones that traditional enforcement models have not been able to capture.

To transform this evidence into action, the work details a shift from reactive spot speed monitoring to more proactive management through Mobile Point-to-Point (hereafter, MP2P) enforcement. This transition is strongly supported by the 2025 Austroads guidelines, which identify MP2P as a preferred method for managing driver speed choice on high-speed and difficult to monitor roads, such as regional areas (D'Elia, 2025). By creating a more consistent sense of enforcement urgency across the network, this approach addresses the psychological tendency of drivers to only comply with limits when a camera is in sight.

Jurisdictional context
The legislative and operational landscape for average speed enforcement varies considerably across Australian jurisdictions. Fixed point-to-point (FP2P) speed cameras have been operational for all vehicle types in Victoria, Queensland, South Australia and the Australian Capital Territory for several years (Transport for NSW, 2025). In New South Wales, the Road Transport Act 2013 was amended in October 2024 to extend fixed average speed camera enforcement to light vehicles, with trial sites activated on the Pacific Highway (between Kew and Lake Innes) and the Hume Highway (between Coolac and Gundagai) from May 2025 (Transport for NSW, 2025). Tasmania has flagged an intention to trial average speed cameras but has not yet commenced enforcement operations, while the Northern

Territory has no average speed enforcement infrastructure in place (Transport for NSW, 2025). Table 1 summarises the current status of average speed and MP2P enforcement across Australian jurisdictions.

Table 1. Average speed and MP2P enforcement status by Australian Jurisdiction

Jurisdiction	Fixed P2P Status	MP2P Status
Victoria	Operational - all vehicles	Not yet deployed
Queensland	Operational - all vehicles (~14 fixed sites)	Not yet deployed
South Australia	Operational - all vehicles	Not yet deployed
ACT	Operational - all vehicles	Not yet deployed
New South Wales	Trial for light vehicles underway (Road Transport Act 2013, amended Oct 2024); two sites active from May 2025	Not yet deployed
Western Australia	Not yet deployed (fixed)	Operational since November 2025, first in Australia
Tasmania	Planned - trial not yet commenced	Not yet deployed
Northern Territory	No average speed enforcement	Not yet deployed

Regarding the terminology used in this paper: in New South Wales, “P2P” is also used in the context of the Point-to-Point Transport (Taxis and Hire Vehicles) Act 2016, which governs taxis and rideshare services. Throughout this paper, “P2P” and “MP2P” refer exclusively to point-to-point speed enforcement technology. With respect to MP2P specifically, WA is, at the time of writing, the only Australian jurisdiction to have transitioned from trial to operational deployment for light vehicles (D’Elia, 2025). The 2025 Austroads report AP-R733-25 characterises MP2P as “relatively new and not yet widely adopted” and notes that the enabling regulatory frameworks needed to support MP2P differ from those required for fixed systems, presenting a challenge for jurisdictions considering adoption (D’Elia, 2025). The WA experience documented in this paper therefore offers a nationally relevant model.

Project description

The deployment of MP2P enforcement represents a fundamental technological development designed to maintain safe speed profiles across long corridors. Unlike fixed P2P systems that require permanent infrastructure, MP2P utilises transportable, trailer-based platforms. The solutions establish entry and exit points along a road segment, using 3DHD radar to track vehicles and capture high resolution images for AI-based Automatic Number Plate Recognition (ANPR). By recording synchronised timestamps at both sites, the average speed is calculated by dividing the surveyed distance by the elapsed time. If the average exceeds the limit, a comprehensive offence package is generated for human review, ensuring drivers maintain a consistent, safe speed throughout the entire enforcement zone rather than just a single point.

A notable feature of the WA deployment is its multi-functionality, trailers were configured to simultaneously detect high-risk behaviours, including mobile phone and seatbelt non-compliance, alongside P2P and spot speed. This method allows jurisdictions to effectively address the combined risks of high-energy impact and reduced reaction times caused by distraction. The use of MP2P enforcement is supported by the report, *Mobile Point-to-Point Speed Enforcement Best Practice Review (AP-R733-25)*, which identified MP2P as the preferred method of expanding coverage on high-speed roads. Austroads recommends “structured operational trials” to collect essential data (D’Elia, 2025).

Findings

The Western Australia Safety Camera Trial provided a dataset of 7,916,963 detections across 170 unique sites, with 58,350 average speed detections.

School zone non-compliance

School zone speeding data was collected during the WA trial. The 17.17% spot speeding rate in 70 km/h school zones during school hours is approximately 49 times the 0.35% rate recorded outside school hours (Table 2), indicating that the elevated risk is concentrated precisely when children are present. Notably, the corresponding average (P2P) speeding rate of 3.65% is markedly lower than the spot rate, suggesting that drivers who exceed the limit at a single point do not necessarily do so across the full corridor, a pattern consistent with the kangaroo effect that corridor-wide enforcement is designed to address.

Post-trial live enforcement results

The transition from trial to program began in January 2025, following the awarding of a multi-function safety camera contract in October 2024. Official enforcement was switched on statewide on 8 October 2025 (Government of Western Australia, 2025c), with MP2P enforcement activated in November 2025. At the time of writing, the following sites have enforced average speed: While these operational snapshots provide critical data on high-volume corridors, meaningful behavioural change is a long-term measurement that requires longitudinal analysis. It is difficult to measure isolated behavioural shifts when data is captured across disparate sites over short durations, as seen in the one-week deployments displayed in the table above. However, this rotation method is a fundamental component of the program’s design, trailers are moved regularly to achieve statewide behavioural change rather than merely improving safety

through small roadway sections. By ensuring that enforcement can occur anywhere and at any time, the program fosters a general expectation of compliance across the entire network, addressing road safety culture at a systemic level.

Table 2. School zone findings

Zone Scenario	Spot Speeding Rate (%)	P2P Speeding Rate (%)
60 km/h Zone (School Hours)	9.24	13.34
60 km/h Zone (Other Hours)	8.61	8.60
70 km/h Zone (School Hours)	17.17	3.65
70 km/h Zone (Other Hours)	0.35	0.03

Table 3. P2P enforcement results

Location	Enforcement Period	P2P Incidents Captured
Forrest Highway, West Pinjarra	19 November - 25 November 2025	135
Forrest Highway, Pinjarra to Ravenswood	25 November - 1 December 2025	214
Graham Farmer Freeway Eastbound	19 January - 27 January 2026	179

Benefits to road safety

The transition from the findings of the 2022 trial to active safety benefits is defined by the shift from identifying corridor-wide non-compliance to implementing a sustained deterrent for speeding. Operational program results underscore the persistence of speeding behaviours that traditional spot enforcement cannot address. By measuring speed over an entire segment, MP2P enforcement directly neutralises the “kangaroo effect”, a critical safety benefit that homogenises traffic flow and reduces speed variability. The primary safety benefit of this technology is the establishment of a psychological “safety halo” that extends across the entire road network rather than just a few hundred metres around a camera. This is particularly vital for regional roads, where almost half of all fatalities occur on roads with speed limits of 100 km/h or more. Rotating mobile trailers across disparate sites, the program encourages drivers to maintain a safe speed profile for their entire journey. The initial trial phase focused on baseline data collection, the transition to live enforcement provides jurisdictions with a proactive solution to manage speed network-wide, ensuring that compliance becomes a consistent behavioural norm rather than an occasional reaction to visible enforcement.

Implications for policy and/or practice

The findings from both the trial and the live operational phase have significant implications for road safety practice, specifically reinforcing the need for corridor-wide speed management. Policy frameworks could recognise MP2P enforcement as a solution to expand geographical coverage on high speed and remote roads that are traditionally difficult to monitor. Additionally, the WA program serves as a proven operational model where MP2P is integrated into a multi-function solution, allowing simultaneous enforcement of distracted driving and seatbelt non-compliance alongside speeding. This promotes efficient methods of enforcement to address multiple road safety challenges via a single platform. Furthermore, non-compliance in school zones identified in the findings necessitates a shift in how speed is managed in vulnerable environments. Practice should move toward flexible monitoring of average speeds throughout entire school precincts, ensuring drivers maintain the reduced 40 km/h limit throughout the danger zone rather than just at a single crossing point.

Conclusions

The data presented in this submission, derived from both the Western Australia Safety Camera Trial and the initial live enforcement phase, provides evidence of sustained speeding behaviours across the WA road network, and the need to mitigate these behaviours through corridor-wide enforcement solutions. Integrating Mobile Point-to-Point technology into flexible, multi-function platforms allows jurisdictions to effectively address speeding behaviours alongside distracted driving and seatbelt compliance, while also neutralising the “kangaroo effect”. As the WA program matures, future work will focus on the longitudinal evaluation of these road safety benefits. Next steps would include the direct measurement of trauma reduction by correlating increased MP2P enforcement density with a decrease in fatal and serious injury crashes. Furthermore, future research should evaluate the safety dividend of managing average speed in conjunction with other concurrent offences, to better understand the impact of simultaneous risky behaviours.

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DRAFT

Understanding drug driving behaviours in NSW to reduce road trauma

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Abstract
Transport for NSW has undertaken attitudinal research into drug taking behaviours including pharmaceutical drugs, medically prescribed cannabis and illicit drugs and how these influence the decision to drive. Drug driving is significantly over-represented in NSW road trauma, and this research is part of a broader program aimed at reducing related crashes and fatalities. A consultant conducted quantitative and qualitative research to examine knowledge, attitudes and self-reported behaviours regarding drug use and driving, as well as the motivations and deterrents associated with driving after drug consumption. The findings indicate that a key factor influencing the decision to drive is individuals' self-assessment of impairment and the belief that their driving ability is not affected by the substances they have taken. These insights will inform future policy development, targeted initiatives, and updated communications to address drug driving and improve road safety outcomes across NSW.

Introduction
Drug driving crashes are significantly over-represented in NSW road trauma, highlighting the ongoing need to develop and implement effective initiatives to reduce harm and improve community road safety. Transport for NSW's (Transport) most recent drug driving attitudinal research was conducted in 2014. Updated research was commissioned to better understand the current attitudes, behaviours, and motivations of drug drivers.

The drug driving landscape has changed considerably over the past decade. The previous research predates significant legislative and enforcement reforms, including the legalisation of medically prescribed cannabis. As the previous research examined cannabis only as an illicit substance, there was a need to better understand driver attitudes and behaviours towards cannabis as a legal pharmaceutical product, including both prescribed and illicit use.

Further research was also required to explore broader community attitudes to drug driving, including the deterrence effect of enforcement. These insights are particularly important following the 2018 expansion of roadside drug testing to include cocaine detection and the introduction of combined drink and drug driving offences in 2021.

Conference theme: From Evidence to Action: Shaping a Brighter Future
Drug driving remains significantly over-represented in road trauma in New South Wales, accounting for up to 30 per cent of fatalities in recent years. Although rates have declined, the scale and persistence of harm require updated approaches to meet 2030 targets. New research examined current attitudes, behaviours and perceived deterrence in the context of major legislative and enforcement changes since 2014, including expanded roadside drug testing and the legalisation of prescribed medicinal cannabis. Delivered through cross-sector collaboration, the findings are being applied to strengthen enforcement, refine public messaging and support targeted behaviour change initiatives.

Method
Transport conducted quantitative and qualitative research to examine knowledge, attitudes and self-reported behaviours relating to drug use and driving, including motivations and deterrents associated with driving after drug consumption. The quantitative component comprised an online survey conducted in September 2024 with a sample of n=5,500 NSW drivers aged 17 years and over. The qualitative component, delivered in December 2024 and January 2025, included 10 in-depth interviews, four focus groups, and a four-day online bulletin board.

The 2024 study retained the 2014 questionnaire, with additional items addressing medically prescribed cannabis. While the previous research used telephone interviews, the 2024 survey was administered online to reflect contemporary survey practices and minimise social desirability bias. The qualitative component, newly introduced in 2024, enabled deeper exploration of key themes and supported a more comprehensive understanding of attitudes and behaviours. Areas examined included drug use (illicit, pharmaceutical and prescribed cannabis), drug driving behaviours and experiences, motivations and deterrents, perceptions and understanding of enforcement, and attitudes towards risk and drug driving.

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Approach to data analysis

To ensure that results are broadly representative of NSW, all data were weighted according to Australian Bureau of Statistics (ABS) demographic profiles, based on gender, age and location (metropolitan and non-metropolitan areas).

- *Those who had used illicit drugs*: Defined as respondents who had used illicit drugs, or had used pharmaceutical drugs not as prescribed, in the past 12 months. This includes instances where medically prescribed cannabis was used outside of prescription parameters (e.g. incorrect dose or frequency).
- Had driven within 6 hours of using a drug: Defined as respondent who had driven within six hours of using an illicit drug or using a pharmaceutical drug outside of prescription parameters.
- Other illicit drug users: Defined as respondents who had not driven within 6 hours of using an illicit drug or using a pharmaceutical drug outside of prescription parameters.
- *Those who had used pharmaceutical drugs only as prescribed*: Defined as respondents who had used pharmaceutical drugs strictly according to prescription in the past 12 months, excluding any individuals who had used illicit drugs. This included medically prescribed cannabis only as prescribed.
- Had driven within 6 hours of using a drug: Defined as respondents who had driven within six hours of using a pharmaceutical drug only as prescribed.
- Other pharmaceutical drug users: Defined as respondents who indicated they had not driven within six hours of using a pharmaceutical drug only as prescribed.

Results

- Over one third (37 per cent) of NSW drivers reported using at least one drug in the past 12 months, including 17 per cent who used illicit drugs and 19 per cent who used pharmaceutical drugs.
- Among those who had used illicit drugs in the past 12 months, 67 per cent had driven within six hours of use. Males were significantly more likely than females to report driving in this period (71 per cent, compared to 63 per cent).
- Fifty-six per cent of those who had used pharmaceutical drugs in the past 12 months had driven within six hours of use. Prevalence of driving after pharmaceutical drug use was broadly consistent across demographic groups, with no statistically significant differences by age, gender or location.
- Just under one in ten (8 per cent) NSW drivers reported using medically prescribed cannabis in the previous 12 months, with 41 per cent of these having driven within six hours of use. Prevalence was higher among younger drivers, males and those in metropolitan areas.

The primary motivator for drug driving was the belief that drug use did not affect their ability to drive safely. Research indicated that self-assessment of impairment and perceived social acceptability of drug use were key influences on the decision to drive. While anticipated embarrassment had limited impact on those who had driven after using drugs, respondents who had abstained from driving after drug use were far more likely to report that being caught would cause shame.

Benefits to road safety

This attitudinal research into drug taking behaviours provides Transport with a detailed understanding of the attitudes, behaviours, and motivations of drivers who use both illicit and prescribed drugs. By identifying the key factors that influence decisions to drive after drug use – including self-assessment of impairment, social norms, and perceived deterrents – this research enables the design of interventions that are targeted, evidence-based, and effective. Insights from the findings support the development of tailored public communications that clearly convey the risks, dangers, and legal consequences of drug driving, helping to influence driver behaviour and reduce road trauma. Additionally, the research informs enforcement strategies by highlighting the aspects of deterrence most likely to impact driver decisions. Collectively, these findings contribute to a coordinated approach across education, policy, and enforcement, strengthening road safety initiatives and supporting ongoing efforts to reduce drug-related crashes and fatalities on NSW roads.

Implications for policy and/or practice

The research is already being applied to support commitments under the Road Safety Action Plan 2026, including the development of modules for the Road Safety Learning Lab and a new drug driving behaviour change campaign. This campaign will be integrated with enforcement activities and reinforced through enhanced communication materials. Insights from the study also strengthen understanding for Transport's partner agencies, including NSW Police and NSW Health, who share the overarching goal of reducing drug-driving-related road trauma. Insight have also contributed to scoping policy decisions regarding medically prescribed cannabis and driving. By informing both education and enforcement initiatives, the research provides a robust evidence base to guide coordinated, cross-agency action and support more effective interventions to improve road safety outcomes across NSW.

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Conclusions

Transport for NSW has undertaken both quantitative and qualitative research to examine current knowledge, attitudes, and self-reported behaviours related to drug use and driving in NSW, including the motivations and deterrents influencing decisions to drive after using drugs. A key finding is that individuals who drive after drug use rely on self-assessment of impairment and generally believe that their driving ability is not affected by the substances they consume. The research also identified a widespread lack of awareness of current NSW legislation and drug driving enforcement practices. These insights provide a critical evidence base to inform future policy development, targeted initiatives, and public communications. As part of a broader strategy to reduce drug-driving-related road trauma, this research supports more effective, evidence-based interventions aimed at improving road safety outcomes across NSW.

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DRAFT

Perceptions of safety in Western Australia's heavy vehicle industry

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Abstract
Heavy vehicles (HV) continue to be over-represented in annual fatal and serious injury crashes. This study aim was to explore current perceptions of safety among trucking HV stakeholders in Western Australia (WA). Interviews (N=25) were conducted with drivers, fleet managers, auditors, trainers, regulators and industry advocates, and thematically analysed. Five overarching themes were identified: Governance and Regulation, Organisational Systems, Individual Factors, Environment and Infrastructure, and HV Industry Culture. Findings suggest that safety is shaped by the interaction of high job demands, uneven organisational systems, and a shifting occupational culture, with fatigue persistently identified as a critical safety threat. Findings have implications for training, licensing, regulatory alignment, and organisational practice, emphasising the need to strengthen professional identity, structural and psychosocial supports towards shaping a brighter HV industry future.

Introduction
Heavy vehicle (HV) transport is essential to Australia's economy, yet drivers operate in one of the country's most demanding and high-risk work environments. During 2024, 198 road deaths resulted from an incident involving a heavy truck, of which 47 (24%) of the deaths were an HV occupant (see Table 29; BITRE, 2025). The majority of the deaths were other vehicle occupants (60%), with the remainder including motorcyclists, pedestrians and cyclists. HVs move agricultural produce, fuel, minerals, consumer goods, construction materials and more, connecting remote regions, with national and international markets (Edwards et al., 2014). The industry supports thousands of jobs, not only for drivers, but also for mechanics, logistics personnel, and the broader freight and manufacturing supply chain. Therefore, HVs are not optional, but essential in Australia.

WA is Australia's largest state jurisdiction in size, comprising almost one-third of the land mass, however, only ~10% of the population reside there, with ~80% residing in the capital city Perth and another ~10% around and south of the capital (ABS, n.d.; Geoscience Australia, n.d.). This results in vast low density areas in all other regions. Major mining and agricultural operations dominate in several of these regions. Often only a single major road corridor connects these networks. Surrounding roads include many unsealed and low star-rated roads that HV drivers must navigate, including delivery of critical supplies for remote communities. Many of these roads fall under the regional default speed limit of 110 km/h; 10 km/h higher than other Australian states.

As with all Australian jurisdictions, regional road environments account for most of the road fatalities each year, with 80% of HV truck fatalities occurring outside of major cities (BITRE, 2025). As such, the HV industry is in need of timely innovations to assist with reducing human errors and improve safety for all road users. We need to better understand current risks and challenges to inform these, as well as measures that can be implemented now to improve road safety.

This study examined how safety is understood and managed within WA's HV industry using the Job Demands-Resources Model as an orienting framework (Nahrgang et al., 2011). The model proposes that job demands, such as workload, time pressure, or emotional strain, deplete energy and contribute to fatigue and burnout, whereas job resources, such as autonomy, support, or positive safety climate, promote engagement, motivation, and resilience. Research consistently demonstrates that job demands increase burnout and reduce safety performance, whilst job resources support engagement and safer behaviour (Nahrgang et al., 2011). The study aim was to explore how people working in or alongside the industry perceive the demands of HV work, the resources that support safety, and the conditions that shape everyday decision-making. A key purpose was to identify modifiable factors that can be addressed now, as well as into the future, to advance road safety.

Conference theme
This research highlights many perceived challenges in the HV industry that impact safety. While fatigue management issues persist, more unique highlights are the perceived loss of status of HVs and their drivers, and insufficient training of local needs for internationally-sourced drivers. Given the heightened role of HVs in annual road fatalities, with most fatalities not the HV occupants, these findings point to key issues to address as part of shaping a bright road safety

future for all road users.

Method

A qualitative design was used to explore the lived experiences of people working within WA's HV industry. Participants were recruited between June and August 2025 using purposive and snowball sampling to capture a diverse cross-section of WA's HV workforce. Eligible participants were aged 18 years or older and had experience in the WA HV industry and/or regular involvement with WA's regulatory environment. Study advertising flyers were posted on LinkedIn and in online trucking forums, emailed to HV industry groups (using contact details sourced from public directories and online searches), and posted at some trucking rest stops within a few hours' drive of Perth. Recruitment continued until data saturation was judged to have been reached, defined as the point at which additional interviews no longer generated new insights. Participation was voluntary and no incentives were offered, apart from the opportunity to contribute to improved HV safety. The qualitative analysis was conducted by both authors applying framework analysis (a sub-type of thematic analysis) in order to explore the findings relative to key concepts of the Job Demands-Resources Model. The study protocol was approved by The University of Western Australia Human Research Ethics Committee (2025/ET000317).

Results

Semi-structured interviews were conducted with 25 participants, including HV drivers, fleet managers, auditors, trainers, regulators and industry advocates. The relevant HV context for companies ranged from large fleets, including road trains, to smaller owner-operators. Participants ranged in age from 25–34 to 75–84 years, with 24% identifying as female. Years of experience in the industry ranged from a minimum of 3-5 years, although for the majority this was 20+ years. Participants covered the industry sectors of mining, construction, agriculture, retail, livestock, manufacturing, dangerous goods and policy/regulations, with some having experience across more than one sector.

Attempts to align the coding framework with the Job Demands-Resources Model proved insufficient. The final five overarching themes were Governance and Regulation, Organisational Systems, Individual Factors, Environment and Infrastructure, and HV Industry Culture. Table 1 summarises the content covered by these themes, which were organised into 22 sub-themes.

Table 2. Themes, descriptions, and sub-themes identified from analysis of participant interviews

Theme	Description	Sub-themes
1. Governance and Regulation	System-level factors, including laws, regulatory frameworks, and market conditions, that shape how safety is structured, managed, and enforced within the HV industry	1.1 Regulatory frameworks and compliance 1.2 Training and licensing standards 1.3 Industry pressures 1.4 Governance and policy gaps
2. Organisational Systems	Organisational policies, management systems, and work structures that translate regulation into daily practice and determine how safety is carried out in everyday operations	2.1 Organisational structure and capacity 2.2 WHS practices 2.3 Workforce resourcing 2.4 Training and development 2.5 Work design
3. Individual Factors	Psychological, physical, and behavioural factors influencing individual drivers' safety, including coping, motivation, and decision-making under pressure	3.1 Cognitive, emotional, and physical demands 3.2 Personal habits and coping strategies 3.3 Professionalism, competence, and decision-making 3.4 Financial pressure and job security 3.5 Life beyond the cab
4. Environmental and Infrastructure	External physical conditions, such as geography, road quality, climate, and facilities, that shape the risks and resources available to drivers on the road	4.1 Geographic and environmental conditions 4.2 Road design, condition, and maintenance 4.3 Facilities and amenities 4.4 Interactions with other road users
5. HV Industry Culture	Shared beliefs, values, and practices within the HV industry that influence attitudes towards safety, learning, and professionalism	5.1 Professional pride and code of conduct 5.2 Mateship, mentoring, and community 5.3 Changing workforce 5.4 Stigma, public perception, and recognition

Findings suggest that safety is shaped by the interaction of high job demands, uneven organisational systems, and a shifting occupational culture. Fatigue emerged as the most persistent safety threat, driven not simply by hours worked but by the cumulative effects of poor sleep, environmental extremes, administrative load, and sustained cognitive effort. Professional identity, mentoring and peer support functioned as important but increasingly eroded safety buffers. This included perceived loss of status of HV drivers in the community and loss of pride in their vehicles, contributing to lower quality vehicles and driver recruitment challenges. Most drivers shared experiences of co-drivers sourced from

international jurisdictions with HV licence accreditation yet lack of knowledge of local HV requirements. Systemic pressures including inconsistent regulation, economic strain, variable training quality and inadequate infrastructure were highlighted. These factors interacted to amplify or mitigate risk, further illustrating the value of viewing safety as a sociotechnical system rather than an individual responsibility.

Benefits to road safety

The findings highlight several areas for immediate investigation and action to improve road safety towards meeting Governments' commitments to dramatically reduce road fatalities and serious injuries by 2030.

Implications for policy and/or practice

While the research identifies many avenues for reform, fatigue risks particularly stand out. It has been more than a decade since the National Heavy Vehicle Regulator was established and National Heavy Vehicle Law introduced in Australia (in 2014; NTC, n.d.). A key intention was to first establish Basic Fatigue Management regulation across the industry before then enhancing to Advanced Fatigue Management. Momentum seems to have stalled on achieving the latter. As WA had recently reformed HV regulations, particularly addressing fatigue, as part of its Work Health and Safety (WHS) regulatory approach it did not join the national regulator at that time. Many participants preferred WA's approach, but also acknowledged practices and risks of misuse. WA HV Accreditation was considered to have lifted standards, although collectively, the different regulatory requirements across state borders was described as confusing and administratively heavy for those working beyond WA. Need for education-training on these, as well as other local needs (e.g., coupling/uncoupling road train trailers) for internationally sourced drivers was made clear. Actionable implications therefore include the need to further reinvigorate and review HV governance and industry policies applicable to these issues at the national, state and industry level. Exploring ways to increase community understanding of the importance of HVs for Australia, to raise status and improve local driver recruitment, is also recommended.

Conclusions

The study contributes qualitative insights into how HV road safety is lived and negotiated in WA's unique geographic and regulatory context. HVs are critical to Australia's economy and Australians' way of life. However, it is perceived that this is not recognised or valued by the Australian public, at least not in WA. Local available drivers appear to be reducing, and further upskilling is needed on local knowledge and skill needs of those sourced internationally. These issues were highlighted across the various HV industry roles and sectors, in addition to the standout message that fatigue remains one of the greatest perceived risks. HVs are an important part of the road safety sector that cannot be overlooked in efforts to reach 2030 road trauma reduction targets; that is, in shaping a brighter road safety future.

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Fatal crash reduction from eliminating speeding in Victoria

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Abstract
Speeding has been found to be common in regular driving, and particularly so in fatal crashes. Prior studies that have examined the benefits of the elimination of speeding in fatal crashes have used methods that may have produced underestimations. The aim of the present study was to produce an estimate of the benefit of eliminating speeding in Victoria, Australia. The study used Even Data Recorder (EDR) data from 59 striking light vehicles involved in fatal crashes in Victoria that occurred between January 2017 and March 2022. The EDR data were used identify speeding and calculate a new impact speed for these cases. Risk curves closely matching the crash type and severity were used to determine the reduction in probability of the crash being fatal. It was found that fatal crashes involving a light vehicle as the striking vehicle could be reduced by 41 to 53% if speeding were eliminated.

Introduction
Travel speed has been established as an important factor in the occurrence and severity of crashes (Elvik *et al.*, 2019). Speed limits are set that define the maximum legal speed at which a vehicle can travel on a particular section of road. One purpose of speed limits is to minimise the risk of fatal and serious injury. Travelling above the speed limit is commonly known as speeding. Speeding, though illegal, is common in regular driving (Stephens *et al.,* 2017) and in crashes (Doecke & Elsegood, 2024).

Prior studies that have examined the benefits of the elimination of speeding in fatal crashes have used methods that may have produced an underestimate. Doecke & Woolley (2011) examined eliminating speeding in the context of limiting intelligent speed assist (ISA-L), a vehicle technology that aims to prevent speeding. Doecke & Woolley found that ISA-L on all vehicles would reduce fatal crashes in Australia by 28%. However, this is likely to be a considerable underestimate as the reduction in fatal crashes was modelled using speed risk curves that describe the relative risk of a casualty crash. The risk of a fatal crash would be expected to be much more sensitive to changes in travel speed than the risk of a casualty crash that includes all levels of injury. More recently, Vadeby (2023) found that eliminating speeding in Sweden would reduce fatal crashes by 25%. This is also likely to be an underestimate as Vadeby (2023) modelled the benefit of the elimination of speeding using only a single value, the reduction in mean speed, rather than considering that the shape of the speed distribution was considerably changed, and the reduction in mean speed came solely from speeds above the speed limit. In addition, both these studies used speed data from general driving rather than crashes. The aim of the present study was to produce an estimate of the benefit of eliminating speeding in Victoria, Australia, using speed data from the EDRs of vehicles involved in fatal crashes, and risk curves closely matched to the crash type and severity level being considered.

Conference theme
This paper demonstrates new **evidence** on the benefits of eliminating speeding with respect to fatal crashes. The finding eliminating speeding would produce a large reduction in fatal crashes provides **evidence** of the value of further **action** to reduce, and eventually eliminate, speeding.

Method
The method used to determine the benefits of eliminating speeding included several steps. The first was selecting cases for analysis. Next, the change in impact speed that resulted from a vehicle travelling at the speed limit, rather than speeding, was calculated. The change in impact speed was then related to a change in the risk of a fatal outcome. Finally, the changes in risk were weighted and summed across all crash types to estimate the reduction in fatal crashes if speeding were eliminated.

EDR data on fatal crashes in Victoria were obtained from the EDR database maintained by the Centre for Automotive Safety Research (CASR), CASR-EDR. EDRs contain pre-crash data recorded from a vehicle's sensors, including vehicle speed. The CASR-EDR database contains EDR data from light vehicles, police report data, and injury data from several sources, including crashes where Victoria Police obtained the EDR data between January 2017 and March 2022. Cases were included if the EDR file was from the striking vehicle and contained relevant speed data, and if the crash occurred on a public road and was not deliberate. There were 59 cases that could be included in the analysis. Over the same period there were 1,165 fatal crashes in Victoria. The cases included in the analysis therefore represented a 5.1% sample of all fatal crashes in Victoria.

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Weighting factors were used to account for the biases within the CASR-EDR fatal data. The known biases were the over-representation of head-on crashes due to both involved vehicles being considered the striking vehicle, and the under-representation of pedestrians crashes due to the recording threshold of some EDRs. Weightings were calculated by dividing the percentage of all Victorian fatal crashes that were a given crash type by the percentage found in the CASR-EDR fatal data of the same crash type. For example, hit-fixed-object crashes made up 28.8% of the CASR-EDR fatal data and 33.7% of all fatal crashes in Victoria, therefore the weighting used for hit fixed object crashes was 1.3.

The calculation of a new impact speed based on a reduction in travel speed had two main steps for cases in which pre-impact braking occurred. The first was to determine the time-to-collision when braking began, referred to as the braking time. The second step was to use the braking time, a reaction time, and the severity of braking found in the EDR data to determine the new impact speed. Detailed information on the methods used in the calculation of the new impact speed can be found in Doecke *et al.* (2021b). The reduction in impact speed for the crashes that involved speeding had a corresponding reduction in risk of fatality. Where the new impact speed was calculated to be zero, the crash was theoretically avoided and had a zero risk of fatality. If the new impact speed was greater than zero, a new probability of fatality was calculated using risk curves. Risk curves from Lubbe, Wu & Jeppsson (2022) were used for pedestrian and cyclist crashes, and from Doecke *et al.* (2020) for all other crash types. The knowledge of a fatal outcome at the original impact speed provided extra information that can be accounted for in the calculation of the reduction in fatal probability. As such, the probability of a fatal outcome at the new impact speed was normalised against the probability of a fatal outcome at the original impact speed, to account for the original fatal outcome. Sensitivity testing was undertaken for the crash types where there were less than four crashes: right turn in front, U-turn in front, and rollover. Overall results were calculated based on a 0%, 50% and 100% crash reduction for these cases to provide an upper and lower bound, and a middle value.

Results

Figure 1 shows the original impact speeds, and the impact speeds that were calculated for the scenario where speeding was eliminated. There were 11 crashes (19%) where the impact speed was calculated to be zero, meaning that the crash would have been completely avoided. There was also a general shift to lower speeds. This was most evident in the reduction of impact speeds exceeding 100 km/h from 18 at the original speed to two when speeding was eliminated, an 89% reduction.

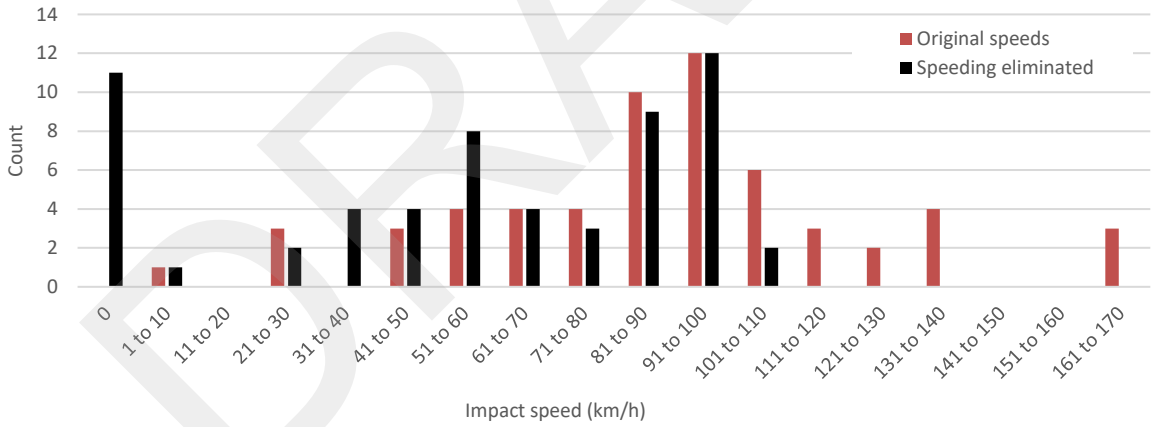

Figure 1. The distributions of the original impact speeds of the striking vehicles involved in fatal crashes, and the impact speeds if speeding was eliminated

The result of eliminating speeding on the average travel speed, average impact speed and the predicted number of fatal crashes are shown in Table 1. It was found that the 25% reduction in average travel speed that was produced by eliminating speeding would result in a 36% reduction in average impact speeds, and a 40% reduction in fatal crashes. When the crashes were weighted by crash type, the percentage reduction in fatal crashes increased to 53%. This increase was largely due to the weighting reduced the proportion of head-on crashes in the sample, which of all crash types showed the least reduction in fatal crashes when speeding was eliminated.

Table 2 shows the results of the sensitivity testing of the overall fatal crash reductions to the fatal crash reductions for the crash types with less than four cases in the CASR-EDR data. The upper bound shown in Table 2 was equal to the weighted result shown in Table 1 as all of the crashes included in the sensitivity testing were found to be completely avoided when speeding was eliminated. If the fatal crash reduction for these crashes was 50%, similar to the crash reductions for the other crash types, the result would have been reduced by 6 percentage points to a 47.1% reduction in fatal crashes.

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Table 1. Results for the reduction in fatal crashes if speeding were eliminated

Variable	Original speeds	Speeding eliminated	Percentage reduction
Average travel speed (km/h)	108.5	81.2	25.2%
Average impact speed (km/h)	89.3	57.1	36.0%
Fatal crashes - unweighted	59.0	35.6	39.6%
Fatal crashes – weighted	59.0	27.7	53.1%

Table 2. Results of the sensitivity testing of the fatal crash reductions of crash types with low numbers

Assumed fatal crash reduction for crash types with <4 cases	Overall fatal crash reduction
0%	41.1%
50%	47.1%
100%	53.1%

Discussion

The reduction in fatal crashes found in the present study (41 to 53%) is much higher than the benefits reported in prior studies that used speed data from general driving, and either the reduction in mean speed to calculate the benefit (Vadeby, 2023) or risk curves based on casualty crashes (Doecke & Woolley, 2011). A portion of the differences between studies may be due to differences in speeding in the areas or time periods examined, though it is also likely due to the methodological limitations of prior studies. Some caution is in order when interpreting the results of the present study, as the sample size is marginal (n=59). It is also important to note that the dataset used was limited to cases where a light vehicle was the striking vehicle therefore the results may not be applicable to crashes where other vehicle types were the striking vehicle.

Benefits to road safety, and implications for policy and/or practice

The findings of this study imply that a high priority should be placed on introducing measures that reduce speeding, with the eventual goal of eliminating speeding altogether. Measures that reduce or eliminate speeding could include ISA or top speed limiters on vehicles, speed enforcement enhanced by public education campaigns, and road infrastructure treatments that require a vehicle to reduce its speed (e.g. raised platforms at intersections).

Conclusions

It was found that, for a sample (n=59) of fatal crashes involving a light vehicle as the striking vehicle, fatal crashes could be reduced by 41 to 53% if speeding were eliminated. As the sample size was marginal, work is underway to collect additional EDR data from fatal crashes for a future, more robust, analysis.

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Road safety strategies in NSW local government

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Abstract
Councils manage most of New South Wales' road network yet road safety isn't often considered beyond baseline requirements. This project develops an update to a practical guide that assists councils to embed road safety so they can plan, fund and deliver road safety as a business-as-usual service. A multi-agency working group ran decision workshops and one-on-one practitioner sessions to diagnose barriers and co-design solutions. Findings confirmed that the existing publication in isolation provided guidance that was too technical and poorly aligned to the required planning and reporting framework. Scheduled for publication in July 2026, the new supplementary tools and resources provide action-oriented pathways and funding alignment strategies. By embedding road safety into organisational processes, this project aims to empower local road authorities to drive gradual trauma reduction and achieve sustainable safety outcomes. By integrating safety with strategy, service planning and long-term financial plans, these resources aim to lift participation, improve delivery discipline and support steady trauma reduction across local networks.

Background
Local government in New South Wales manage over 167,000 kilometres of regional and local roads, which account for approximately 80% of all roads in the state (IPWEA NSW & ACT, 2025). This local network represents an enormous public asset valued at around $103 billion in replacement cost (IPWEA NSW & ACT, 2025). Due to this scale, the everyday decisions councils make about planning, maintenance and upgrades have major implications on road safety outcomes.

Local government contribution to achieving the 2030 and 2050 targets for reductions in deaths and serious injuries is a significantly underutilised lever. Despite the 'Vision Zero' targets of the State and Federal governments, local government has no mandated role to contribute toward these outcomes. There may be good reason for this. Many councils face tight revenue limits, assets rated in poor or very poor condition have a combined replacement cost of $6.3 billion (IPWEA NSW & ACT, 2025) indicating long-term under-investment and mounting renewal needs. A 2024 NSW Government inquiry (Parliament NSW, 2024) found that an alarming proportion of councils in NSW are financially unsustainable in that their total level of income is well below what is required to maintain their assets at current service levels.

Overlooking the financial challenges, there are an array of additional barriers preventing local governments from being more active in reducing road trauma. A survey conducted in the initial stages of the project identified staff turnover, lack of buy-in from executive and elected leadership and uncertainty about how safety fits within routine planning and reporting cycles as some of these barriers. Together, these factors mean that even when councils want to improve road safety, they often lack a clear, practical way to integrate safety into their everyday work.

My organisation identified a need for a resource so councils understand how they can navigate these challenges and engrain road safety in their organisation. This culminated in a publication that informs and educates council staff as they develop, implement and review Road Safety Strategies at a local level. Over the years as the road safety industry has matured, and the council landscape has shifted, together with changes in State and Federal Government policy, an update to the guide was required. This took the form of supplementary tools and resources that respond directly to these gaps, recognising the significant barriers councils face while establishing how road safety can be embedded within the mandated planning and reporting framework, enabling councils to plan, fund and deliver safety improvements as part of their normal business.

Conference theme
Due to their significant role as roads authorities, local government are perhaps the greatest lever for impacting road safety outcomes. But they are currently hindered by significant barriers, as highlighted in the data above, this statement is supported by clear evidence. The more work the road safety industry can do to reduce or remove these barriers will mean more councils can directly implement road safety initiatives to reduce the burden of road trauma. This project highlights one piece of work that aims to reduce these barriers, it highlights how the knowledge and understanding of systemic local government challenges, coupled with information and tools on best practice in road safety management has been applied to deliver a simplified, action-oriented pathway local government can use to transfer the wealth of information within the road safety industry into practical application.

Project description

The development of the resources was driven by recognition of the changing local government landscape in addition to feedback on the current edition, which in isolation was identified as being "too complex, not fit for purpose, and a deterrent to implementation". Key findings from a survey and stakeholder workshops also highlighted a lack of alignment with the Integrated Planning and Reporting (IP&R) framework, insufficient detail regarding funding (grants versus council investment), and lack of executive buy-in as barriers that would need to be addressed.

To inform and address these gaps, a working group was established with representation from council practitioners, state government representatives, private road safety consultants and subject matter experts. The process included several decision-making workshops and one-on-one sessions where expert advice was sought. An engagement plan was initially developed which identified the key stages of the project, and when advice or decisions would be required, this informed the timing and purpose of each stakeholder meeting. The collective sessions provided a clear pathway to address barriers and issues with the current edition. Following a review by the working group, the new resources will be published in July 2026.

Findings

A conclusion was drawn through this process that councils do not necessarily lack the resources to improve road safety, rather the systems and goals they work towards do not have road safety engrained as a core focus. An example of this is in asset management where councils make funding decisions for their assets, it is common practice to prioritise works on criteria that does not include road safety such as remaining asset life. These new resources now provide guidance on how councils can integrate road safety into daily operations by having criteria for road safety in evaluating and prioritising various infrastructure programs.

Another key finding through this process, counterintuitively, was that the guide by itself is too road safety specific. The updated resources intentionally focus on how road safety fits within the broader responsibilities of local government including how it aligns within the IP&R framework. This method ensures that road safety strategies won't be 'left on the shelf' and are integrated across the organisation's operations.

As identified in the survey on the existing publication, buy-in from executive and elected leadership remains a significant barrier. Through the project workshop sessions, it was recognised that the most effective position we could take is to empower champions within councils to inform and educate their leaders on road safety by providing them with the resources and direction to influence their leaders.

Overall, the findings indicate that improving road safety at the local government level is less about introducing additional resources internally and more about reshaping organisational systems, priorities and leadership engagement. The review process highlighted that when road safety is aligned with established planning, reporting and decision-making frameworks and when internal champions are equipped to influence executives and elected members it is far more likely to be embedded as business-as-usual rather than treated as a standalone initiative. Together, these insights informed the development of a suite of resources and tools that shifts the focus from prescriptive road safety actions to enabling councils to integrate safety into their core functions, creating the conditions for more consistent and sustainable improvements in road safety outcomes.

Benefits to road safety

These resources are specifically designed to cut through the barriers that often prevent councils from considering road safety in day-to-day operations. By lowering the barrier to entry, these tools and resources make road safety more palatable for local road authorities, allowing them to effectively use their position for the 2030 and 2050 Vision Zero targets. It provides the necessary tools for councils to implement the Safe System approach within their specific local contexts.

Implications for policy and/or practice

This work demonstrates how reviewing and updating practitioner guidance can strengthen the role of local government in reducing road trauma. By aligning road safety with councils' mandated planning and reporting frameworks, the updated resources reframe safety as a core organisational responsibility rather than a discretionary activity. This approach directly addresses a key barrier identified through the review process: councils often support road safety objectives but lack clear, practical pathways to embed them in everyday decision-making, particularly in asset management, program prioritisation and long-term planning.

At a policy level, the guide supports the intent of the NSW 2026 Road Safety Action Plan (TfNSW, 2022) by enabling safer local communities through improved governance, strategic alignment and local leadership. It also responds to issues raised by the NSW Audit Office (Audit Office, 2023) including low uptake of the Local Government Road Safety Program (LGRSP) and limited integration of safety into council business-as-usual processes. By focusing on

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systems, executive engagement and funding pathways, the guide helps bridge the gap between state policy direction and on-ground delivery.

In practice, adoption of the guide is expected to lead to gradual but sustained reductions in road trauma as councils consistently incorporate safety considerations into infrastructure planning and investment decisions as well as community engagement, programs etc. While benefits will accrue over time, this approach sets a precedent for future policy development that embeds road safety into core planning and reporting cycles, ensuring safety remains a sustained priority across the NSW local road network.

Conclusions

This project demonstrates the value of deliberately reviewing and updating guidance to reflect both the maturity of road safety practice and the evolving operating environment of local government. Through a structured, collaborative process involving practitioners, subject matter experts and government stakeholders, the review identified why previous guidance failed to gain widespread traction – namely due to an excessive technical focus, misalignment with councils other strategic plans, and limited consideration of financial and organisational realities. The supplementary tools and resources respond to these shortcomings by reframing road safety as a core business function, embedding it within the IP&R processes, funding decision-making and asset management practices.

The review and co-design process itself was critical to ensuring the resources are practical, relevant and usable, particularly for councils facing resource constraints and competing priorities. Following publication, future work should focus on monitoring uptake, evaluating how councils apply the guidance in practice, and periodically refreshing the resources to remain aligned with policy settings, funding mechanisms and emerging best practice, ensuring it continues to support sustained reductions in road trauma over time.

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Evaluation of the NSW Safer Drivers Course

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Abstract
Young drivers face elevated crash risk in their first months of solo driving. The NSW Safer Drivers Course (SDC) supplements the Graduated Licensing Scheme with a 3-hour facilitated group module and a 2-hour in-vehicle coaching session undertaken with another learner, and awards 20 bonus logbook hours. Using linked licensing, infringement, crash and program data (2003–2025) and aggregate quasi-experimental models, we found SDC participation is associated with 6% fewer crashes, 5% fewer sanctions and 10% fewer offences. Individual person-level models produce larger reductions but are more susceptible to unobserved selection. Time series analyses suggest sustained gaps in sanctions and offences for several years after P1 licensing. Survey and interview findings support plausible mechanisms of change, notably peer learning and immediate application of theory to practice, and indicate the SDC is a positive, scalable complement to the graduated licensing journey for road safety practitioners.

Introduction
The first 6-12 months of independent driving carry the highest crash risk for novices in Australia, reinforcing the value of countermeasures that target hazard perception, self-regulation and decision-making. International and Australian evidence indicates that strengthened licensing systems reduce novice-driver trauma (e.g., Senserrick et al., 2018). The NSW Safer Drivers Course (SDC) supplements the NSW Graduated Licensing Scheme through a 3-hour facilitated group discussion and a 2-hour on-road coaching session with another learner, and awards 20 bonus logbook hours for eligible learners under 25 (NSW Government, n.d.). This evaluation – a government/industry collaboration – examines whether SDC improves safety outcomes and why it may work in practice, using administrative data, quasi-experimental methods, surveys and qualitative interviews and discussions.

Conference theme
This work supports ARSC2026's theme, "From Evidence to Action: Shaping a Brighter Future," by translating robust evaluation into practical guidance on behavioural mechanisms (peer learning; immediate practice) and its place complementing graduated licencing for novice drivers.

Method
The evaluation team analysed linked Transport for NSW licensing, infringement, crash and program datasets. Two models were used:

- Aggregate, two-step age-by-quarter regression exploiting staged SDC uptake to estimate population-level impacts (primary estimates); and
- Individual person–quarter model controlling for age, gender, First Nations status, instructor hours, postcode socio-demographics, calendar quarter and time since P1 test (secondary estimates).
  Pre-rollout baselines probed selection effects. Limitations include incomplete demographic fields, unavailable at-fault status, and potential residual selection.

In addition, other evaluation data sources included:

- Surveys of SDC participants (n=545) and their parents (n=115); and
- Interviews and focus groups with SDC participants (n=29), their parents (n=20), government stakeholders (n=4), facilitators/coaches (n=4), course providers (n=7) and training providers (n=2).

Findings
Primary (aggregate) estimates associate SDC participation with 6% fewer crashes, 5% fewer sanctions and 10% fewer offences. No statistically significant change was detected using the aggregate model for serious crashes due to the small amount of cases and the resulting volatility of longitudinal data. While individual level estimates yielded bigger reductions, they may be subject to unobserved selection effects and are not included here.

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Time-series analyses suggest sustained gaps in sanctions and offences for several years post licensing. Subsidised SDC participants display higher baseline risk than modelled benchmarks, confirming effective targeting but limiting causal attribution for this subgroup due to comparison group constraints.

Survey and focus group findings support a plausible causal pathway through the learning design of SDC utilising elements of peer learning and immediate application of theory to practice. Care needs to be taken with these findings, as while the analysis has attempted to control for selection bias, unobserved selection effects may still be in force.

Survey findings indicated that while the majority (81%) were motivated by the bonus logbook hours, similar proportions (83%) reported better understanding of safe driving practices and feeling more confident managing driving risks. Qualitative methods showed that participants and stakeholders regarded peer learning as central to behaviour change, namely:

- Group discussion normalises safe driving choices
- Hearing peer experiences increases credibility and emotional impact
- In-vehicle peer observation reinforces hazard awareness

Benefits to road safety

The SDC appears to deliver early outcomes – fewer offences, sanctions and crashes – consistent with improved self-regulation and safer decision-making during the highest-risk novice phase. The course's peer discussions and coached practice provide practical, scalable mechanisms to embed safer norms and skills.

Implications for policy and/or practice

Taken together, the observed pattern of results implies that retaining (or expanding) the Safer Drivers Course (SDC) as a feature of the graduated licensing journey is warranted, because the most consistent, statistically reliable gains occur on near-term outcomes (offences and sanctions) that theory and prior evidence position as antecedents to crash reductions, particularly during the early months of solo driving when risk is highest (Siskind, 2023). Tracking compliance outcomes alongside crash data and trauma metrics captures both earlier movement in behaviour and later movement in harm.

Impact is also likely to hinge on how the course is delivered. The hypothesised mechanisms – peer learning in the facilitated group setting and immediate practice during coached driving – are experience dependent, so variation in facilitation and coaching plausibly modulates effect size, because these components translate attitudes and hazard management skills into on-road behaviour (NSW Government, n.d.; Siskind, 2023).

Finally, evidence that subsidised participants enter with higher baseline risk has a dual implication: continuing access for priority cohorts aligns with equity and system level harm reduction; however, credible judgements about effectiveness for these learners require better comparison data and explicit eligibility identifiers, because current administrative records constrain like-for-like causal contrasts. A genuine counter-factual will often be difficult to achieve given information is (with good reason) only recorded for subsidy recipients. There may be benefit in deploying a staggered intervention control process if an SDC-like course is introduced in other jurisdictions.

Conclusions

SDC participation is associated with moderate population-level crash reductions and stronger reductions in offences and sanctions. Together with plausible mechanisms of peer learning and immediate application of theory to the practice of driving, these findings suggest that the SDC is a positive, scalable addition to novice driver safety in NSW.

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DRAFT

Enabling fit-for-purpose network safety planning for local government

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Abstract
Local governments are increasingly expected to undertake proactive, network-wide safety planning under Australia's Safe System approach and the National Road Safety Strategy 2021-2030. However, councils often lack the time, staff, data and expertise to select and implement approaches that are proportionate, affordable and defensible. This paper presents the development and trial of a *Local Government Network Safety Plan Guide* that provides a framework to support proactive, network-wide safety planning on local road networks. The framework is supported by a state-led approach that provides councils with standardised information on their systemic crash risks and safety performance metrics across corridors and intersections. This approach reduces the assessment burden on councils and supports consistent prioritisation of infrastructure and speed management investment. Application across metropolitan, regional and rural local government contexts has demonstrated improved decision clarity, consistency and transparency, supporting a shift away from reactive, site-based treatments toward strategic, network level safety management.

Background
Local governments manage about 80% of the road network by length, carry approximately 36% of vehicle travel, and experience over half of all casualty crashes, including an estimated 40% of fatal crashes (Austroads, 2010; IPWEA, 2024). Despite this exposure, many councils continue to face challenges implementing fit-for-purpose network risk assessment and safety planning processes.

Research has identified persistent barriers to local governments undertaking network-wide risk assessments, including limited capability to select and apply appropriate methodologies, constrained access to consistent data, and resourcing limitations (Department of Infrastructure, Transport, Regional Development, Communications and the Arts, 2024). Survey and interview findings indicate that many councils lack sufficient budgets or staff, have limited time due to competing priorities, and are affected by staff turnover that erodes road safety knowledge (ibid). These constraints have contributed to continued reliance on reactive, crash-history-based approaches, particularly on lower-volume networks where crashes are dispersed and less reliable as predictors of risk.

The same body of research highlights the efficiency and consistency benefits of state or territory-led approaches, where higher-level agencies use economies of scale to undertake or coordinate assessments and provide local governments with standardised, policy-aligned risk information (Department of Infrastructure, Transport, Regional Development, Communications and the Arts, 2024).

Conference theme
This work addresses the conference theme *From Evidence to Action: Shaping a Brighter Future* by demonstrating how Safe System evidence and national guidance on fit-for-purpose local road risk assessment can be translated into a practical, repeatable planning process that is achievable within typical local government capability and resourcing constraints.

Project description
Consistent with previous research, practitioner feedback confirms that capacity, capability and resourcing constraints remain key barriers to local government undertaking comprehensive network risk assessments (Department of Infrastructure, Transport, Regional Development, Communications and the Arts, 2024). In response to these issues and the network-level risk management expectations for local government set out in the National Road Safety Strategy 2021-2030, Victoria's Department of Transport and Planning (DTP) developed a *Local Government Network Safety Plan Guide* and accompanying resources to support proactive, network-wide safety planning on local road networks.

The following section details the network safety planning process set out in the *Local Government Network Safety Plan Guide* and highlights key innovations initiated by DTP to support local governments with the most resource-intensive early steps of the process, reducing the technical and data burden on councils.

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Findings

A Network Safety Plan (NSP) is a strategic, proactive and evidence-based plan aligned with Safe System principles. It describes the long-term (2050) vision of safety for the road network in terms of the speed limits and infrastructure required to substantially minimise the risk of death and serious injury (Austroads 2025). It benchmarks current conditions and identifies the speed management initiatives and infrastructure improvements required to achieve this vision across the network. The primary output of a NSP is an investment plan – a prioritised program of works that contributes towards national and state road safety targets by optimising investment in treatments that best contribute to the 2050 vision of safety for the road network while still allowing for the inclusion of highly cost-effective treatments that address systemic risks and/or high-risk parts of the road network. The investment plan is costed and can be implemented as funds become available, either through council funding streams, or via external state and federal funding programs.

The *Local Government Network Safety Plan Guide* developed by DTP assists Victorian Local Government Areas (LGAs) develop their NSP. The Guide sets out an evidence-based, seven-step approach for LGAs, as shown in Figure 1.

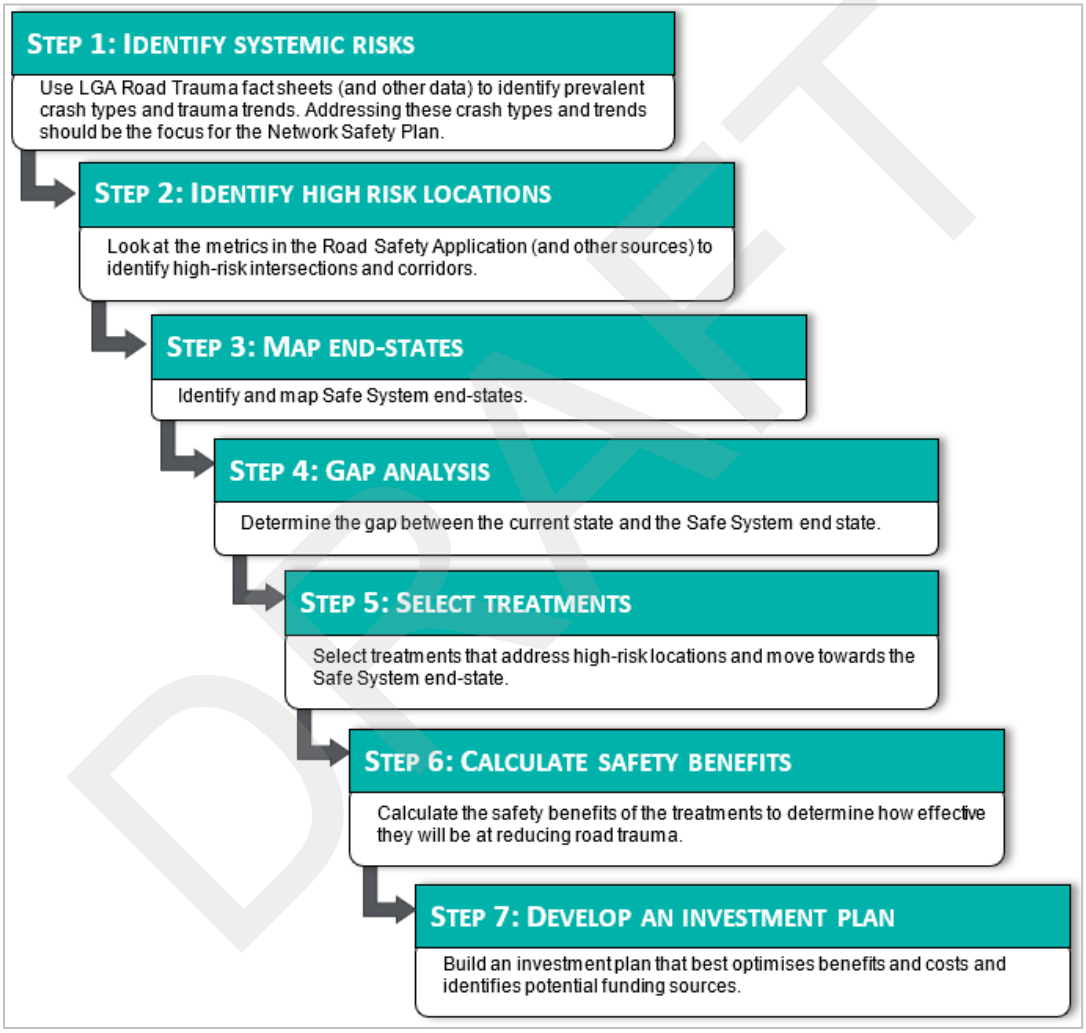

Figure 1. Steps in developing a Network Safety Plan
Source: Victoria Department of Transport and Planning (reproduced with permission)

Key innovations

DTP delivered two innovations to support local governments with the most resource-intensive early steps of the process, reducing the technical and data burden on councils. The first of these was preparing and disseminating of standardised 'Road Trauma Fact Sheets' for every LGA. These fact sheets summarised fatal and serious injury trends by road user type, crash type and location, and enable comparison with peer local government areas. This allows councils to clearly identify dominant and over-represented systemic risks (Step 1 above) on their network and focus subsequent analysis and investment on the issues most likely to drive serious harm.

The second innovation was modelling and mapping proactive risk (Infrastructure Risk Rating [IRR] and reactive (Collective Risk) road safety metrics for all local road corridors and intersections (Austroads, 2019). These metrics are

shared with LGA through a Power BI Road Safety Application and enable councils to identify and interrogate high-risk locations on their networks without requiring resource-intensive local data collection or having each council develop its own analytical model (Step 2 in Figure 1).

LGA practitioner feedback

The *Local Government Network Safety Plan Guide* was released for trial across metropolitan, regional and rural contexts to test usability, scalability and integration with existing council processes. Feedback from practitioners confirmed the guide is an effective tool for infrastructure planning and risk assessment for local road networks with practitioners able to move beyond isolated, site-specific problem definitions and articulate systemic safety risks more clearly. The use of standardised fact sheets, mapped risk metrics, defined Safe System end states and structured gap analysis improved transparency and consistency in decision making. Practitioners reported increased confidence in justifying priorities to internal stakeholders and funding bodies, and in developing investment plans that balance long-term Safe System objectives with short- and medium-term delivery constraints. Following this successful trial, the Guide was released to all Victorian LGAs in late 2025 to support standardised, proactive road safety management practices.

Benefits to road safety

By providing local governments with centralised information on systemic risks and high-risk locations, the framework enables earlier and more consistent identification of priority corridors and intersections than would be possible through reactive, crash-history-based approaches alone. The use of standardised fact sheets and mapped risk metrics improves the visibility of network-wide risk patterns, enabling more defensible decisions about where limited safety investment will have the greatest impact. Over time, consistent application of the NSP process facilitates a shift toward proactive treatment of systemic risks, contributing to sustained reductions in fatal and serious injury risk and aligning investment with the 2050 vision for the road network.

Implications for policy and/or practice

National guidance recommends that state and territory governments define fit-for-purpose local road risk assessment methods and provide councils with the data and tools needed to apply them (Department of Infrastructure, Transport, Regional Development, Communications and the Arts, 2024). The *Local Government Network Safety Plan Guide* demonstrates how this direction can be implemented in practice by pairing a repeatable planning process with centrally prepared inputs for systemic risk identification and high-risk location mapping. This approach supports consistent prioritisation across councils while reducing inequity between well-resourced and resource-constrained local governments.

Conclusions

Local governments are expected to undertake fit-for-purpose network safety planning, yet widely documented constraints in capacity, capability and data access continue to limit consistent implementation. Victoria's *Local Government Network Safety Plan Guide* provides a practical pathway to embed Safe System principles into local government planning, with a key innovation being the provision of state-led inputs for the early stages of the process. By improving decision clarity, consistency and defensibility, the framework provides a credible, scalable pathway toward sustained reductions in road trauma.

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Enabling safe speeds through practitioner-centred processes

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Abstract
Speed management is a proven Safe System intervention, yet many jurisdictions struggle to translate evidence-based guidance into consistent, defensible on-road outcomes. This paper presents a case study of the 2025 update to the NSW Speed Zoning Standard, informed by an independent review of the 2023 version. While the review confirmed the robustness of the underlying principles, it identified persistent barriers to implementation, including limited practitioner confidence, variable organisational support, and decision-making processes that were difficult to explain and defend. In response, the updated Standard strengthens traceability between principles, processes and outcomes; embeds Movement and Place concepts; and translates guidance into clearer, action-oriented direction. Supporting evidence on the safety benefits of lower speeds, together with new training and engagement resources, was incorporated to promote consistent and defensible application. This paper will be of interest to jurisdictions updating speed zoning guidance or seeking to accelerate implementation where progress has been slower than desired.

Background
Speed is a primary determinant of both crash likelihood and injury severity, and safe speed limits are central to the Safe System approach (Austroads, 2026). Despite a mature evidence base, many jurisdictions struggle to implement lower speed limits consistently at scale. While public acceptance and political risk are often cited, internal capability, practitioner confidence and decision explainability are equally critical constraints.

In NSW, an independent review of the 2023 Speed Zoning Standard found that while the principles were broadly aligned with Safe System thinking, there were persistent barriers to implementation. Feedback from internal stakeholders indicated that speed limits generated by the Standard did not always align with practitioner expectations or appear intuitive, reducing confidence in recommendations and increasing reliance on discretionary judgement. The review concluded that addressing isolated technical issues alone would be insufficient to facilitate widespread implementation, and that greater emphasis was required on practitioner support, decision clarity and explainability.

The findings of the independent review resulted in an update to the NSW Speed Zoning Standard that was published in July 2025 (Transport for NSW, 2025) along with a suite of supporting training and engagement resources for practitioners.

Conference theme
This work directly addresses the ARSC 2026 theme, *From Evidence to Action: Shaping a Brighter Future*, by demonstrating that moving from evidence to implementation depends not only on what the evidence says, but on how decision systems are designed and how practitioners are supported to apply them with confidence. By strengthening decision transparency, traceability and practitioner capability, the updated Standard provides a practical pathway for converting Safe System principles into consistent implementable outcomes.

Project description
The 2025 update to the NSW Speed Zoning Standard was developed in response to an independent review of the 2023 version and delivered through a deliberately practitioner-centred process. Rather than treating practitioners solely as end users of the Standard, the update positioned them as co-designers of the speed zoning system, recognising their central role in translating policy intent into on-road outcomes. Speed zoning practitioners were engaged throughout the development process to test alternative criteria, thresholds and decision pathways, with a particular focus on whether outcomes were intuitive, explainable and operationally realistic. The resulting changes to the speed zoning process and decision framework are outlined in the following section.

Findings
This section outlines how the updated speed zoning process translates speed zoning principles into consistent, explainable speed limit outcomes, and how changes introduced in the 2025 Standard strengthen this translation in practice.

In the 2025 NSW Speed Zoning Standard, this process begins by explicitly embedding the NSW Movement and Place framework into decision-making (Transport for NSW, 2024). Practitioners first identify the relevant street environment,

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place context and street type for each road segment, reflecting its movement function, place value and surrounding land use. Based on this classification, an evidence-based safe speed limit range is specified, defining the upper and lower bounds of acceptable speed limits for that context. These ranges establish clear, system-level expectations for safe speeds and provide a transparent starting point for all speed zoning decisions.

Selection of a specific speed limit within the defined range is then guided by a structured assessment of moderating factors that reflect the road's design, operation and risk profile. These factors vary by street type and place context and include elements such as access controls, alignment, traffic volumes, and traffic calming measures. Infrastructure and operating characteristics that reduce crash likelihood or severity support selection toward the upper end of the range, while features associated with higher exposure or conflict support lower speeds. Specifying factors by street type supported efficiencies within the review process, allowing for more of the network to be reviewed compared to the existing process. This two-stage approach—establishing a context-appropriate range and then refining the outcome using objective factors—strengthens consistency, reduces reliance on discretionary judgement, and improves traceability between policy principles, practitioner assessments and final speed zoning outcomes.

Key changes introduced in the 2025 update reinforce this approach through clearer and more objective decision pathways, stronger integration of Transport for NSW Design of Roads and Streets Manual, and explicit documentation requirements that improve traceability from principles to recommended speed limits. A prioritisation framework was also introduced to support staged delivery across a large and diverse road network, enabling practitioners to focus implementation where safety benefits are greatest. In parallel, new training, guidance and communication resources were developed to build internal capability and support more consistent, evidence-based conversations with stakeholders and communities.

Supporting material

An example of supporting material developed for practitioners as part of the 2025 update to the NSW Speed Zoning Standard demonstrates how changes to speed limits and complementary infrastructure treatments influence road safety outcomes, using iRAP Star Ratings as a consistent measure of risk. Through worked examples across representative rural and urban road environments, it illustrates how alternative speed and design scenarios translate into measurable changes in risk for different road users (refer Figure 1).

Figure 1. Star rating of rural highway with 90 km/h speed limit, widened shoulders and ATLM
Source: Abley Limited (reproduced with permission)

By providing a clear, evidence-based link between speed zoning decisions and safety performance, this supporting material helps bridge the gap between policy intent and practical application. It assists practitioners to understand the relative effectiveness of speed management and infrastructure investment, improving consistency, confidence and safety-led decision-making in the application of the 2025 NSW Speed Zoning Standard.

Evidence base

The 2025 Speed Zoning Standard is supported by evidential technical analysis. Analysis conducted as part of the project was modelling the potential safety impacts of the Standard on the NSW state and regional road network. The assessment used Elvik's Exponential Model as the basis for determining the change in crashes and injuries resulting associated with implementing a specified speed limit.

$$Change\ in\ crashes\ (or\ injuries) = 1 - e^{\text{coefficient} \times (\text{speed after} - \text{speed before})}$$

The before and after speeds in the model are operating speeds rather than speed limits. Operating speed changes were estimated using representative average responses by street type, consistent with understanding expected safety benefits from implementing the Standard at a strategic, network-wide level.

The assessment highlighted that implementation of the 2025 NSW Speed Zoning Standard on all state and regional roads could reduce fatal crashes by 20%, serious injury crashes by 14% and all injury crashes by 11%.

Benefits to road safety

By enabling more consistent and defensible speed limit decisions, the 2025 Standard supports the systematic delivery of safer speeds across the road network. Clear speed limit ranges and objective moderating factors reduce reliance on discretionary judgement, lower the likelihood of ad-hoc exceptions, and improve alignment between technical recommendations and final approvals. This increases the probability that evidence-based speed limits are both implemented and sustained over time, contributing to reductions in crash severity and road trauma, particularly on higher-risk regional and rural roads. Network-level analysis indicates that substantial safety benefits can be realised if the Standard is applied consistently across all state and regional roads in NSW.

Implications for policy and/or practice

The NSW experience demonstrates that effective speed management policy must address both technical design and organisational capability. Pairing evidence-based speed zoning guidance with clearer decision logic, explicit documentation requirements and practitioner-focused support materials improves decision transparency and accountability, while reducing internal friction and escalation risk. Jurisdictions seeking to strengthen speed management outcomes can apply these lessons by designing speed zoning systems that are not only technically robust, but intuitive to apply, explain and defend. Investing in practitioner capability, supported by training, guidance and communication resources, is critical to accelerating implementation and achieving safer speed outcomes at scale.

Conclusions

Translating safe speed evidence into action requires decision systems that practitioners and the community trust and can apply consistently. The updated 2025 NSW Speed Zoning Standard illustrates how practitioner-centred design and clearer decision logic can bridge the gap between evidence and implementation, supporting safer speed outcomes at scale.

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Didn't know or didn't care? Complexities of repeat offender motivations

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Abstract
Data from safety camera technology introduced to detect illegal seatbelt and mobile phone use on Western Australian roads been effective in reducing the overall incidence of illegal behaviours, however, a notable proportion of drivers reoffend. In response, exploratory survey research engaging 283 illegal mobile phone and seatbelt use reoffenders was conducted, aiming to identify factors that contribute to reoffending, and sentiment towards safety camera technology. Participants' attitudes towards, knowledge of and reasons for engaging in illegal behaviours varied, reflecting different priorities, along with varied understandings of, and regard towards, law and technology. Understanding reasons for seatbelt and mobile phone reoffending is essential to inform targeted interventions and deterrence strategies to ensure the ongoing effectiveness of road safety initiatives. Findings suggest value in a range of interventions that are responsive to road user behavioural motivations and demonstrate that rich, local evidence can provide insights for tailored action.

Background
Fixed (freeway) and mobile (trailer) safety cameras, equipped with artificial intelligence (AI), have expanded detection capabilities beyond speeding to include seatbelt misuse and illegal mobile phone use. These technologies provide a valuable source of naturalistic data on offence types and patterns, strengthening the behaviour change evidence base. To introduce Western Australian (WA) drivers to this new form of safety camera technology, a caution-notice period was incorporated prior to the issuing of infringements. Initial data indicated that safety cameras are effective in reducing the overall incidence of illegal behaviours, with declines observed in speeding, mobile phone use, and seatbelt offences (Zhen & Ferreira, 2025). This is consistent with evidence from a systematic review indicating that enforcement-based interventions, including speed/safety cameras, can contribute to reductions in road trauma and support behaviour change through deterrence mechanisms (Pilkington & Kinra, 2005). However, a notable proportion of drivers continue to reoffend despite receiving caution notices.

Between 11 February and 6 July 2025, a total of 43,940 (41,111 metro, 2,504 regional, 325 out of state) WA drivers received a caution notice for mobile phone or seatbelt offences. This raised crucial questions about driver motivations and contextual factors influencing their continued non-compliance with the law. In response, independent research was conducted. The overarching objective was to identify the underlying factors that contribute to WA drivers repeatedly engaging in illegal driving behaviours to build the evidence base used to inform targeted road safety behaviour change interventions. As exploratory research, design and interpretation was inductive and intentionally not informed by established behavioural frameworks. Attention was made to understanding road user attitudes towards, knowledge of, and rationale for engaging in the illegal behaviour(s). Suggestions to help curb future illegal driving behaviours and sentiment towards the use of safety cameras as a road safety behaviour change strategy was also gleaned.

Conference theme
Understanding why some drivers repeatedly engage in illegal road use behaviours helps build the evidence base used to inform road safety behaviour change initiatives. Evidence from this research tells us that there are diverse reasons why WA drivers are reoffending and suggests that a one-size-fits-all approach to behaviour change will be ineffectual; instead, action for behaviour change warrants tailoring. In this way, our research honours the conference theme by demonstrating how local evidence can inform local action.

Method
This research was carried out in accordance with ISO20252 standards. Between 9th October and 10th November 2025, 6,320 WA drivers who received two or more caution notices during the caution notice period were invited via mail to participate in a confidential survey consisting of closed and open questions. A total of 283 drivers completed the survey. Although the sample is small and reflects a self-selection bias, for qualitative research it engaged 'good informants' who were keen to convey their perspective. Qualitative responses were coded inductively into broad themes manually by independent coders. Responses for each question were quantified against these themes and quotes extracted for illustration. All participants were eligible to enter a prize draw on completing the survey, with six prizes allocated.

Findings

57% of participants were male, 41% female, and 2% preferred not to identify their gender. Majority of participants (22%) were aged between 25 and 34 years.

Majority of participants reported receiving caution notices for one offence type – mobile phone use (36%, n=102) and seatbelt (19%, n=55), compared to 3% (n=9) of participants receiving both mobile and seatbelt notices. 5% (n=13) were unsure of the offences they received caution notices for and 15% (n=43) could not recall receiving caution notices. 22% (n=61) were not driving for any of the offences. The n reported in the subsequent sections will vary as some questions were based on specific behaviours, dependent on participant recall of the notices they received, and whether they were the driver (e.g., car driven by a family member).

Driving without a seatbelt was considered harmful by 87% (n=247) of participants, while considerably less (70%, n=198) believed that driving with a seatbelt but wearing it incorrectly is harmful. Around eight in ten participants (82%, n=233) considered holding a mobile phone while driving to be harmful, while only 45% (n=127) considered holding a mobile phone while the car is stationary in traffic to be harmful.

Illegal Seatbelt Use (n=64)

42% (n = 27) reported they were aware their seatbelt behaviour was illegal prior to receiving the caution notices, and overall, participant understanding of legal seatbelt use varied. For example, 98% (n=63) of participants correctly identified that partially wearing a seatbelt with the cross-body sash behind your back is illegal, whereas only 22% (n=14) understood that wearing a seatbelt with the cross-body sash too high is also illegal. Participant perceptions regarding the clarity of seatbelt laws also varied, ranging from 33% (n=21) of the opinion that the laws were moderately clear, and 16% (n=10) reporting they did not find the laws to be clear at all. Of those participants who reported some lack of clarity in seatbelt laws (n=57), the most common suggestion as to how to make the laws clearer was via awareness and education (58%, n=33). Participants suggested advertising and education campaigns and requested explicit details such as how to correctly position the seatbelt on your body.

The main reason reported by participants for illegal seatbelt use was due to discomfort (28%; n=18). This was followed by forgetting/being unaware they were not wearing their belt (e.g., *"I simply forgot to put it on"*) and medical reasons such as injury (*"I had a shoulder injury and the pressure of the seatbelt on my collarbone was agitating it"*), both at 15%; n= 10. Around one in ten (11%, n=7) rejected the assertion they were wearing their seatbelt illegally, while 6% (n=4) were of the belief that it is their choice to wear or not wear a seatbelt, with one participant reporting *"I wanted to keep my freedom, to wear it or not"*. Notably, some drivers held the opinion that deciding to wear a seatbelt was *their* decision and not wearing a seatbelt was a risk they were willing to take; in such instances the potential impact on others (e.g., first responders, witnesses) does not appear to be factored and instead favours their perceived individual liberties.

The main suggestions offered by participants to encourage legal seatbelt use included the use of caution notices as an enforcement measure, and understanding the safety implications of not wearing a seatbelt correctly. For example, "*Knowing the serious risks of injury or death from not wearing a seatbelt encourages me to always wear it properly. Getting the caution notice also made me realise how easily accidents can happen."* Coupled with participant suggestions for clearer communication of seatbelt laws, for some repeat offenders, education may present as an avenue for behaviour change. Such a strategy would likely not be effective for repeat offenders who believe wearing a seatbelt is their choice.

Illegal Mobile Phone Use (n=111)

48% (n = 53) reported they were aware their mobile phone behaviour was illegal prior to receiving the caution notice. Participant understandings of what constitutes illegal mobile phone use varied. For example, 94% (n=105) understood holding a mobile phone while driving was illegal, whereas 65% (n=72) knew it was illegal in stationary traffic to rest a mobile phone on any part of the body. Participant clarity of mobile phone laws similarly varied, but most participants (87%, n=95) reported some lack of clarity in the laws. 65% (n=63) of the participants suggested that greater community awareness of laws would be beneficial. Of these, 25% (n = 24) felt it was imperative that communication is more specific about what is and is not legal.

The main reasons reported by participants for illegal mobile phone use reflected how they were using their mobile at the time of the offence, namely using maps/GPS devices, followed by positioning phone on lap (67%, n=74). Nearly one in ten (8%, n=9) report they had a vehicle or technology issue that necessitated them touching their phone, for example, a broken phone mount or car connectivity problems. Other reasons included: what was considered an emergency (9%, n=10 e.g., *"My car speaker wasn't working. My mum was admitted in ICU overseas. So I was getting calls and didn't want to miss it."*), a work purpose (8%, n=9, e.g., *"It's a bad habit of being a healthcare professional and being on call. Need to answer clinical calls or see notifications - cannot wait the whole freeway drive home."*), habit (8%, n=9, e.g., *"Force of habit and life stresses (work, kid logistics etc)."*) and a lack of awareness that their actions were illegal (5%, n=6).

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The main suggestions by participants to prevent illegal mobile phone use were behavioural (55%, n=60; e.g., getting a handsfree mount), followed by enforcement (40%, N=44; e.g., receiving a caution notice).

Sentiment Towards Safety Camera Technology

Support for the use of safety camera technology as a road safety behaviour change initiative was nuanced. 72% (*n* = 205) support the use of cameras capturing passengers not wearing seatbelts or children not having proper child car restraints, whereas 62% (*n* = 176) support the use of cameras capturing drivers not wearing a seatbelt and/or using a mobile phone while driving. This difference in support may reflect drivers grappling with their perceived civil liberties in light of laws and the responsibility they have for passenger safety. At times, camera technology and use of AI were viewed as an invasion of privacy and overstretch of policing, for example, *"Big brother is coming for us all."* Relatedly some participants criticised technology and threats to individual liberties, for example, *"None of your business whether people wear their seatbelt or not as it doesn't effect anyone else. Been driving for many years daily, never had a crash and I don't necessarily follow all the rules."*

Benefits to road safety

Understanding the reasoning behind illegal road use behaviours is crucial if we wish to implement effective road safety behaviour change strategies. Behaviour change interventions can have greater efficacy if the intervention is appropriately tailored to the needs of the individual (Ryan & Lauver, 2004). Within a road safety context, this translates to appreciating that road users are not homogenous, and as evidenced in our research, neither are recidivist illegal seatbelt and mobile phone use offenders. This research benefits road safety by contributing to the evidence base on reoffending behaviours and motives, and offender responses to the use of safety camera technology; the latter providing insight on the diversity of community sentiment regarding the use of AI and camera technology as a road safety strategy.

Implications for policy and/or practice

Our findings demonstrate that people appear to be reoffending for different reasons. Findings contribute to the existing evidence base that a one-size-fits-all approach to road safety behaviour change is likely ineffectual and point to where interventions could be tailored. For example, findings convey gaps in road users' understanding of the law, suggesting that some road users may benefit from targeted and specific education on legal mobile phone and seatbelt use. Additionally, for some drivers illegal phone use appears to be viewed as worth the risk prompting consideration of factors (e.g., family, work) that pressure drivers to remain connected, suggesting merit in educating and supporting drivers in the uptake of handsfree technology. Such findings are informing education campaign development. Finally, knowledge that some drivers appear to disregard the law conveys an important message regarding the diversity in offender perceptions regarding authority and enforcement. This finding, particularly as it intersects with the pursuit of individual liberties, suggests that initiatives like road safety education are likely ineffectual, whereas diversionary techniques may be more effective in facilitating behaviour change amongst this cohort of drivers. Future research will consider the nuances of road user groups more closely including intentional offending.

Conclusions

Our research contributes insights regarding the attitudes towards, knowledge of and reasons for repeated engagement in illegal seatbelt and mobile phone use, along with offender sentiments towards the use of AI and technology in road safety behaviour change. To translate evidence into sustained action, requires appreciation of the diversity in repeat offender behavioural motivations and the value in tailored interventions that understand and are responsive to the complexity and nuance of these motivations.

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DRAFT

The safety of large-scale transportation of hydrogen by road

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Abstract
In the Netherlands it has become evident that the increase in intensity of the traffic and cost cutting on safety assuring essentials adversely affects the number and seriousness of accidents including such involving road tankers. As is clear, the energy transition will lead to a fast and rapid increase in the use of hydrogen and other energy carriers, which most likely will be transported in a liquid state and at (very) low temperatures. Besides road transport, there are, theoretically, other options and modalities for transporting such energy carriers. However expansions of transportation capacities, other than through road tankers and tank-containers cannot be realised in a relatively short term, matching the increase of the production of hydrogen and other energy carriers and becoming available from various on-going projects. “Shaping a brighter future” by ensuring "the safe, large-scale transport of hydrogen and other energy-carriers” is a prime target of Dutch authorities.

Introduction
Constructing new pipelines in the Netherlands, as has been demonstrated in recent other projects, will likely take longer than 10 years. Although transporting (hazardous) liquids by pipeline is usually the safest solution, the processes leading to the availability of a (new) pipeline are often lengthy due to the need for zoning plan changes, the need to acquire the numerous required plots of land for the route, compliance with public consultation procedures, resistance from various (environmental) groups, and other interests such as speculators. Rail faces similar growth challenges. The current railway network in the Netherlands is "full." Expansion projects resulting in new railway lines, such as the "Betuwe North Branch”, are progressing very slowly if at all.

The transport option of "inland shipping," though considered relatively safe, will be less quickly realized. Both the economically sound design and financing of the construction of the necessary "dedicated" tanker-ships, coupled with the limitations of available waterways and the accessibility of desired and available loading and unloading points, will result in lengthy implementation processes. Furthermore, this mode of transport still presents some headaches, such as degassing, double-hull designs, skipper training, and so on. A more quickly feasible option could be the use of (inland) container ships and the use of tank containers for, and filled with, hydrogen or energy-carrying liquids.
The beauty of tank containers is that these can be transported multimodally, by road, on a chassis trailer, rail, or by inland vessel. Investors and transporters also benefit from the fact that a tank container is a cheaper and faster-to-implement option for (bulk) transport than, for example, road tankers, rail tank wagons, or inland tanker ships. It therefore seems inevitable that road transport, by tanker truck or tank container on chassis trailers, will grow in the short term. The choice of mode of transportation of hydrogen is therefore not primarily determined by politics, but is a consequence of the (rapid) developments in energy market transitions, the availability of means of transportation and the economic, legal and climate limitations that presents itself.

Evidence
The environment in which drivers of a road tankers perform their work is becoming increasingly complex and thereby less safe. Almost inconspicuously and often without drivers being fully aware of this, every aspect in the working environment changes incrementally and progressively in complexity. Furthermore, drivers of road tankers are increasingly held responsible for coping herewith while not receiving any dedicated training nor working instructions thereto.

Relevant topics of such working environment include:
- the increasingly higher safety and environmental standards of the (off-)loading locations,
- the expansion of automation, digitalization and communication being implemented,
- subjection to more legislation and liabilities,
- truck technology, tracking, tracing and planning,
- training of driving non-secured, dynamic liquid loads with increasing pay loads over total truck weight ratio’s and increasing engine power of the trucks,
- Driving behaviour of other road users and the architecture of road infrastructures.

The papers: “The unchallenged acceptance of road tanker accidents” and “The working environment of drivers of road tankers, both E. Eenkhoorn as prepared for and presented at the ARSC, 2023, detail the many and various topics, all impacting negatively on the safety of the transportation of (dangerous) liquids in road tankers and tank containers,

thereby confirming the evidence of the gravity of the current status of the transportation of (dangerous) liquids over the road in the Netherlands. Many of such topics aggravating such safety can and should be actioned forthwith, to ensure a contribution to “Shaping a brighter future”.

But the driver is not the only source to be subjected to safety related improvements. The on-going research also addresses the cargo, the prime originating source of safety risks and its possible condition changes during transportation. And, resulting from this, the design and construction requirements of hydrogen containment systems, as applied for the transportation of LNG, rather than “tanks”, addressing also the need for re-conditioning facilities to become available on hydrogen carrying road tankers and tank containers. The Authorities in Netherlands focusing on “Safe-by-Design” philosophies question whether a traditional tank or “liquid holder”, as applied in road tankers or tank containers, provided basically with an in-/outflow and (over-) pressure safety relief-valve, is the “maximum which can be done” to ensure future safety of large-scale road transportation of hydrogen and other energy carriers.

Conference theme

Both the afore “Introduction” and “Evidence” paragraphs describe how the work detailed in this abstract and intended to be expanded on in the subsequent paper, and thereby meet the ARSC2026 conference theme *From Evidence to Action: Shaping a Brighter Future* requirements, fully.

Method

The method of following-up the results, conclusions and follow-up recommendations of studies as presented at the ARSC, Cairns, 2023 and quoted above, involves the next methodically step. In this step, the “Safe-by-design-basis” frame-work was to result, allowing for the follow-up by many detailed projects, covering a fast multi-disciplinary spectrum, which by aggregation shall culminate in practical solutions and answers, leading to the ultimate target of zero accidents (on the road) in an imminent world in which large-scale transportation of hydrogen and other energy carriers takes place.

Results

Some of the results clarifying the basis of a "safe-by-design framework " to truly achieve "safety", are:

1. Road transport takes place exclusively in and through environments with no or as few people as realistically possible. This means that loading points for larger quantities (tank truck volumes) to much smaller quantities (users, "cars") of hydrogen-rich energy carriers must be located outside built-up areas. In more densely populated areas (cities), the safety of road transport is increasingly difficult to guarantee, and alternatives, such as the use of pipelines over short distances, possibly in existing (old "corridors" for gas pipelines as available in the Netherlands), should be explored. "Safe-by-design" must therefore keep (partial) choices open both during and after the design phase, involving modes other than road transport as alternatives.

2. Other road users should preferably be kept at a great (safe) distance from an location of an in-/accident which has already progressed to a “very serious” level or has the potential to escalate into one, to limit the number of people within a certain radius of such location. One option is to activate the “matrix warning signs”, that are hung above highways and roads, to show the (red) “X” above all approach routes leading to the accident location. Possibly, additional warnings and information on for example “what to do and what not”, the (potential) seriousness of the situation, especially in the relevant (incident) area, are distributed. This can already be done via radio or via an “Alert alarm” via mobile phones. “Safe-by-design” also means giving emergency services quick access to, and maximum reachability of, said location, by minimising road congestion and the number of cars and trucks, especially such with dangerous goods.

3. "Safe-by-design" means being "in control" at all times, during the entire operational transportation phase of each and all road users transporting larger quantities of hydrogen or other dangerous energy carriers. This means, among other things, continuous, permanent monitoring of all on-going transports and loads, and that this information is immediately available to emergency services. To achieve this, the following is required:

- Databases of all tank trucks, possibly tank containers, or other transport (and packaging) options for transporting hydrogen-rich energy carriers and of all drivers qualified to drive road tankers, tank containers, or other options for transporting hydrogen-rich energy carriers and loading them.
- A real-time database of the contents of each tank truck with core data such as temperature, pressure, compartment fill level, and tank truck location. Information similar to that already exists in centralized traffic monitoring and control systems, such as those used for airplanes and trains. These existing information infrastructures could potentially serve as a good basis for road tanker transportations.
- Research into the possible possibilities of using current “Electronic Data Recording” (EDR, possibly also “DDSAD”) type of systems, with the expansions to include cargo condition data recording.

The aforementioned safety monitoring guards should also have access to the tanker trucks' surrounding cameras. This shall be easier now newer road tankers are equipped with new camera-type "mirrors." This shall also allow for monitoring the behaviour of other road users and the road tanker environment at any given time and create opportunities to penalize road users whose "reckless driving", compromises road safety.

4. A final result in this abstract to conclude the "Safe-by-design" framework concerns emergency assistance. Emergency services and first responders should also, preferably, remain at a safe distance from an in-/accident involving a hydrogen-containing road tanker, for example by using remote-operated robotic type of equipment. Such equipment may largely be identical to such already being used by explosives clearing services.

Benefits to road safety

Now drivers of road tankers, or of trucks loaded with a tank container, are the only individuals directly determining how prone the transportation of dangerous liquids is to incidents or accidents. These individuals , constantly, have to be conscious of the behaviour of the cargo, of other road users, of the truck driving conditions, etc. These individuals have to make instant personal decisions in case such behaviour deviates from the anticipated. The various “safe-by-design” solutions will result in “shared responsibilities” by adding cargo condition and surrounding traffic monitoring by persons other than the drivers all safety related aspects. But also, by dedicated provisions in road infrastructures, including cargo emergency re-conditioning facilities, by a new design and construction of road tankers, especially by new cargo (re-)conditioning and load securing provisions, and by truck driver professionalism (education, training, etc.).

Implications for policy and/or practice

The implications for policies and/or practices are many and complex, involving virtually every thinkable discipline ranging from the political to the technical scientific, from tangible to virtually intangible and from immediately possible, desirable to “longer-term”. The Dutch authorities recently approved the “Hysafe” Programme, initiating the implementation of the many, various projects based on the “safe-by-design” method.

Conclusions

The energy transition being a fact and the upscaling of large-scale transport of hydrogen and other energy carriers by road being imminent, there is an urgency to address all issues and topics determining in any possible manner the safety of such transportation and to ensure the practical implementation of the entire solution. Furthermore, a structured, methodological approach is a “must” for the complex type of target.

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DRAFT

Gathering the evidence of Ryda's impact on young road users

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Abstract

The role of education on shaping attitudes and behaviour on young road users has been a key contributor to the reduction in youth fatalities this century, but measuring the impact of educational programs on participants can be complex, time consuming and costly. Over 7,000 pieces of student feedback from the Ryda program were collected in 2025, including in pre-, post- and 3-months-post participation evaluations, short surveys and free text submissions. Analysis of this feedback indicates a significant growth in knowledge on key road safety concepts, a significant fall in willingness to engage in risky behaviour, and high levels of application of strategies on the road. This study explores how the youth voice is systematically collected, analysed, and applied to help shape future iterations of the program and measure behaviour change.

Background

In 2000, young people, those aged 17-24 in Australia and 15-24 in New Zealand, made up 26% of all road fatalities, with 580 fatalities. By 2025, this had fallen by 55% to 259 – a much steeper decline than total fatalities (Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts, 2026). Still, vehicle occupants (drivers and passengers) make up a 75% of all youth road fatalities, a higher proportion than any other age group, although this has trended lower in recent years as pedal and motorcycle youth fatalities have both increased. Given this over-representation, a number of programs target young road users, including preventative road safety initiatives (either for all road users or with a focus on drivers and/or passengers) and driver education (such as safer driver programs). Graduated Licensing Scheme (GLS) restrictions placed on novice drivers – focusing on impairment, distractions and speed –also aim to change young driver behaviour. Despite significant falls, young male drivers and passengers remain the largest fatality group in Australia:

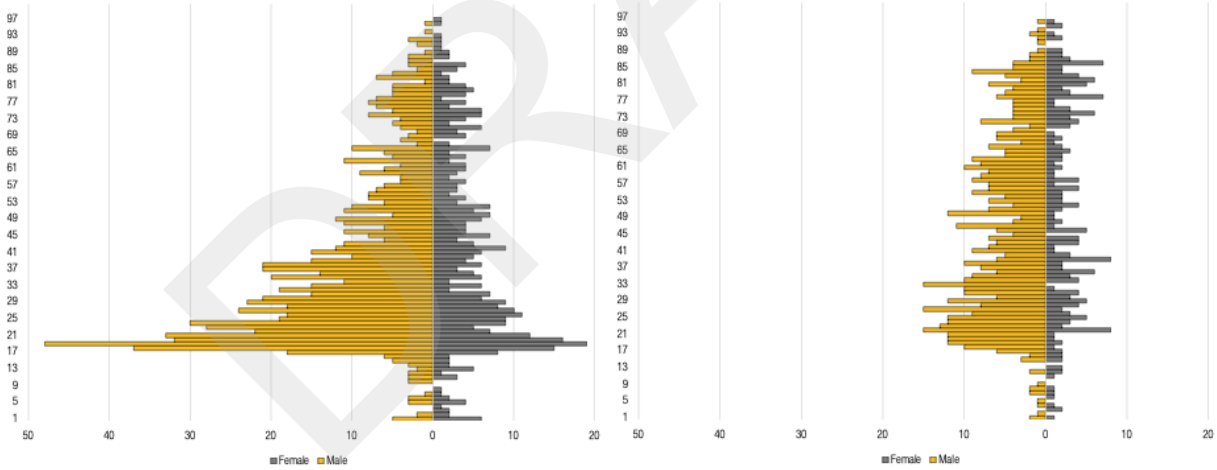

Figure 1. AU Vehicle occupant fatalities by age and gender, 2000 (left) and 2025 (right)
Source: Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts, 2026

Given the range of preventative measures in place to insulate young road users from road trauma, identifying a direct causal link between participation in any one road safety education program or activity and a reduction in exposure to road trauma is problematic. Young road users benefit from the cumulative effect of multiple interventions (including other elements within the safe system), and exposure to road trauma also impacted by a myriad of socioeconomic, geographical, lifestyle factors.

Road safety education practice

Ryda has twice been independently evaluated and benchmarked against recognised road safety education good practice guidelines – first in 2020–21 by the New Zealand Council for Educational Research mapped against and, more recently, in 2024–25 by MAIC (Lewis *et al*, 2025). These guidelines align with those used across several jurisdictions, including New Zealand (NZ Transport Agency, Waka Kotahi, 2026), Queensland (Queensland Government, Department of Main

Roads, 2021), Victoria (Road Safety Education Victoria, 2026) and South Australia (Department of Infrastructure and Transport [DIT], 2026).

Now in its 6th major iteration, Ryda has been providing evidence-led road safety education to students across Australia and New Zealand since 2001. Over 900,000 students have participated in the program, making it the largest road safety education program across both countries. In 2025, 63,460 students from 754 schools participated. Ryda is provided by Road Safety Education Limited (RSE), a not-for-profit organisation, and receives significant support from governments (NZ, QLD, NSW, TAS), corporate sponsors (BOC, Toyota, Bridgestone, Boral, NZ Steel and AMI), Rotary clubs throughout Australia and New Zealand, and local businesses and organisations. RSE uses a combination of available funding and data on school communities' capacity to contribute (including school ICSEA in Australia and Schooling Equity Index in New Zealand) to channel funding where it is needed most. As a result, in 2025 half of all participating schools were servicing disadvantaged communities.

Ryda is built around the key factors that contribute to serious crashes involving young drivers: speed, impairment (alcohol, drugs and fatigue), distraction and seatbelts. The program features an engaging workshop delivered in small class groups and uses a range of educational strategies – including group work, role play and strategy development and practice – to build resilience and support safe decision-making by young people as both drivers and highly influential passengers. At the workshops, whole year cohorts from years 10 to 12, depending on the time of year and jurisdiction, are divided into smaller groups, and proceed through six 30-minute sessions. The workshop is supported, both pre and post, by experiments, lesson ideas, a self-paced online revision course and other resources that help teachers extend the learning back in the classroom and embed a culture of road safety throughout the school.

As part of the whole of school approach to road safety education, RSE also provides Driver Coach, a program for parents and carers of learner drivers, which is offered both face-to-face and via online webinars.
The Ryda program is updated annually, guided by an Advisory Council, literature reviews, and feedback from participating students and teachers. Each new iteration incorporates emerging road safety issues, developments in educational practice, and refreshed content.

Conference theme

This work directly addresses the ARSC2026 conference theme *From Evidence to Action: Shaping a Brighter Future*. It covers the processes of evidence collection to assess the impact of the Ryda program on young road users, the results of these processes in 2025, and how this data supports continual program updates and increased participation in the program. By gathering evidence of road safety knowledge growth, improvements in attitudes to safe road use, and the application of Ryda strategies by participants as both drivers and passengers, it shows that Ryda is an integral part of developing a positive road safety culture.

Project description

RSE used seven evaluation tools throughout 2025, three for students, two for teachers and two for parents and carers. These ran concurrently with the workshop elements of the Ryda program, which run throughout every week of the school year across Australia and New Zealand. These include:

- Three-phase evaluation – all Ryda schools are invited to have their students participate in online surveys that are completed prior to the workshop, immediately after the workshop, and three-months post workshop. This includes knowledge, attitude and behavioural questions. 2020 participants, including 440 who completed all three surveys.
- Short student survey – all students are invited to complete a short online survey at the conclusion of Ryda workshop that includes knowledge, attitude and projected behaviour questions. 2,648 responses.
- Free text response – all students are invited to complete a separate, free-text online response, to share, in their own words, their key outcomes from participating in Ryda, with 5,295 responses.
- Attending teacher surveys – for teachers who attend Ryda workshops to supervise their students, including their perceptions of the efficacy of the program and its content, and how road safety relates to and is covered within their teaching area, with 2,048 responses.
- Organising teacher surveys – for the coordinating teacher about the process of booking in and supporting Ryda participation for their school, rather than on the content, with 93 responses.
- Parent survey – for parents and carers, with 193 responses.
- Driver Coach participant surveys – for participants in the online and face-to-face Driver Coach sessions, usually but not exclusively, the parents and carers of learner drivers, with 292 responses.

All evaluation tools have been independently assessed by RSE's Advisory Council and through the MAIC's Evaluation of to ensure robust design. Participant data is stored securely, accessible only to selected RSE staff, and is de-identified before being shared with external audiences.
Student participants are encouraged to complete evaluations through the chance to win a small incentive. Teacher participation in surveys is a mandatory element of participation in the subsidised program.

Findings

Key findings from the research indicate that:

- Student knowledge grows significantly across 9 of 10 road safety themes. Only the question about alcohol does not show a significant jump in knowledge, as students have a strong existing understanding of the impacts of alcohol on road use. Overall, the percentage of correct answers to knowledge questions increased by 99.7% between pre- and post-Ryda surveys, and stayed high at 75.0% above pre-Ryda results three-months post.
- Compared with pre-Ryda results, Ryda students were 54% less willing to use their mobile phones while driving, 53% less willing to drive while fatigued, 44% less likely to speed, and 30% less likely to incorrectly wear, or not wear, a seatbelt. Pre-workshop willingness was broadly consistent with results from the Victorian Road Safety Monitor (Transport Accident Commission, 2025), providing a useful benchmark for attitudinal change.
- Three months after participating in Ryda, among students who had already commenced driving (including on Learner or Provisional/Restricted Licences), 93% had applied a strategy they learnt at Ryda on the road, with 78% applying half of more of the listed strategies.
- 89% of students felt more prepared to tackle road safety strategies after participating in Ryda, including 44% feeling much more prepared.
- 100% of teachers rated Ryda as worthwhile, including 79% rating it as very worthwhile. 98% of teachers believe Ryda should be compulsory for senior secondary students.
- 91% of parents believe Ryda has reduced risk taking behaviour in their teen.

RSE conducts these surveys annually, allowing longitudinal data to identify changes to efficacy over time.

Benefits to road safety

Measuring the impact of road safety education programs on participants is essential to ensure programs achieve their intended outcomes and that finite funding and resources are channelled to programs that create desired changes in knowledge, attitudes and behaviour. With schools and parents often making opportunity cost decisions about program selection in an imperfect information environment, robust and reliable evaluation data on program outcomes can improve decision-making. This in turn encourages participation in programs that support better decision-making by young road users, potentially reducing their exposure to road trauma, costly non-injury crashes, and licence suspension.

Implications for policy and/or practice

Evaluations are central to measuring the impact of all education programs. With finite funding available for all road safety measures, evaluation demonstrating positive on-road decision-making can assist policy makers in undertaking cost-benefit analysis of road safety educational programs and inform the judicious allocation of funding. Findings provide insights into program design, indicating where more emphasis is needed (such as fatigue, distractions, seatbelt use, speeding) and identifying areas where content is already well understood or near universal positive attitudes exist (such as alcohol consumption)

Conclusions

While reductions in road trauma cannot be attributed to any single intervention, education leading to knowledge acquisition and attitudinal and behavioural change that is delivered according to recognised good practice principles is expected contribute to improved road safety outcomes, not only for participants but for those with whom they share the road. With the biggest data sets available for your road safety programs, Ryda demonstrates strong growth in knowledge, positive attitudinal change, and the application of safety strategies on the road, with encouraging implications for funders and policymakers.

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DRAFT

Who tells pregnant women about seatbelt safety? Evidence from Australia

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Abstract
Motor vehicle crashes account for up to three-quarters of trauma during pregnancy. Correct seatbelt positioning reduces the risk of maternal and fetal injury, yet evidence suggests many pregnant women do not receive information about proper use. We surveyed women receiving antenatal care at the Royal Hospital for Women (Sydney, Australia) between February–March 2026 regarding whether they had received information about seatbelt use during pregnancy and where it was obtained. We also reviewed NSW Health, hospital, and Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) policy and patient information documents for references to seatbelt guidance in pregnancy. Among 88 respondents (mean gestation 31.9 weeks), only 7 women (7.9%) reported receiving information about seatbelt use during pregnancy. Sources included media (n=3), midwives (n=2), friends/relatives (n=2) and doctors (n=1). Thirteen women (14.8%) reported actively searching for information, most commonly online. A review of policy and guidance documents identified limited references to seatbelt use in pregnancy. Antenatal care currently represents an underutilised pathway for communicating evidence-based seatbelt safety information to pregnant women. Integrating clear guidance into clinical resources and antenatal education may improve safety behaviours during pregnancy.

Background
Correct seatbelt use is important for protecting the health of a woman and her fetus during pregnancy as motor vehicle crashes account for up to three-quarters of all trauma that occurs to pregnant women (Connolly et al., 1997; El-Kady et al.,. 2004; Ikossi et al., 2005; Zangene et al., 2014; Sato et al., 2022). Yet evidence suggests many pregnant women fail to correctly use seatbelts (Koppel et al., 2025). Recently Koppel et al. reported that 88% of 1491 Australian women surveyed reported they had received no information during pregnancy about seatbelt use. Similar findings have been reported internationally, where a lack of information about seatbelts contributes to this problem of incorrect use (McGwin et al., 2004; Carlsson, 2023).

Pregnant women undertake regular antenatal visits with a range of clinicians. Therefore, antenatal care is an important pathway for delivering information about seatbelt use. However, as in other countries this information pathway appears to be underutilised, without concerted intervention effort (McGwin et al., 2004). From the Koppel et al. (2025) findings, we expect this is also likely in Australia, but this has not been recently examined.

In this practitioner paper, we examine the role played by antenatal clinicians in providing information about correct seatbelt use through (i) a survey of pregnant women in Sydney, New South Wales (NSW), Australia and (ii) a review of health information, policy and guidance documents for pregnant women and clinicians in NSW, Australia. Finally, the findings are used to present a set of recommendations for action in policy and practice to optimise information in antenatal care to improve seatbelt use among pregnant women in Australia.

Conference theme – From Evidence to Action: Shaping a Brighter Future
This presentation aligns with the conference theme by translating evidence on correct seatbelt use in pregnancy into practical opportunities for action within antenatal care. Our findings identify gaps in information communication and highlight antenatal clinicians as trusted messengers who can influence behaviour change. By strengthening guidelines and patient information, and educating clinicians, antenatal services could improve correct seatbelt use and reduce preventable injury risk for pregnant women and their babies.

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Method

The data presented is from (i) a survey of women receiving antenatal care from the Royal Hospital for Women in February and March 2026 and (ii) a review of policy and guidance documents from NSW Health, Royal Hospital for Women and the Royal Australian College of Obstetricians and Gynaecologists (RANZCOG).

The survey: pregnant women ≥18 years of age with a single or multiple pregnancy; having antenatal care at the Royal Hospital for Women; ≥20 weeks gestation with English language proficiency. Women attending for antenatal care were approached by a researcher or via study flyers in the clinic waiting rooms. After providing consent, eligible participants took part in an observational study being reported elsewhere and completed an in-person survey. In addition to collecting sociodemographic information, the survey asked "Have you ever received information about seatbelt use during pregnancy (including getting verbal advice)?" with possible yes/no responses. If the participant responded 'Yes', they were then asked "Where did you get information about seatbelt use during pregnancy?" and asked to select all that apply from the following list "Doctor, Midwife/Nurse, friends or relatives, a book about pregnancy, a booklet or written instructions given by a doctor or midwife/nurse, media (radio, television, social media, etc), and other". If they selected media or other, they were asked to provide further details. They were also asked "Have you searched for information about seatbelts since becoming pregnant?, and if they responded "yes', they were asked where they searched.

Sample characteristics and survey responses were summarized using descriptive statistics. The survey was part of an observational study approved by South Eastern Sydney Local Health District. The document review: Policy, guidance and patient information documents written by NSW Health, the Royal Hospital for Women, and RANZCOG were identified and reviewed. Any details related to the use of seatbelts during pregnancy and/or advice to be provided on seatbelt use during pregnancy were extracted and summarised.

Results

A total of 97 women were recruited and survey questions responses are available for 88 women. These women were aged between 19 and 46 years with a mean age of 34.2 years (SD 4.8), between 20 and 41 weeks gestation (mean 31.9 weeks, SD 6.2 weeks). Few (7/88, 7.9%) reported having received information about seatbelt use during pregnancy. When asked about the source of the information, two reported multiple sources, and the remaining five reported only a single source. Table 1 summarises the sources of information reported by the group of pregnant women who had received information about seatbelt use during their pregnancy.

Table 1: Frequency of source of information about seatbelt use during pregnancy

Source	Doctor	Midwife/Nurse	Friend/ Relative	Pregnancy Book	Written info from clinician	Media	Other
Frequency	1	2	2	0	0	3	1

Among those reporting a media source, all three described a form of social media. Slightly more women (13/88, 14.8%) reported that they searched for information about seat belt use during their pregnancy. Only one of these women reported searched multiple sources. The most common search source was 'Google' (9 mentions) and two participants reported they searched Google about accessories to reposition the seat belt. Two participants mentioned they searched 'online' with no further detail, and a further two described asking "ChatGPT". One participant searched 'TikTok".

Health related policy and guidance sources reviewed are summarised in Table 2. No documents specifically addressed information about seatbelt use during pregnancy, although seatbelt use was mentioned in patient information about travel in pregnancy and in clinician guidance about trauma in pregnancy.

Benefits to road safety

This study highlights a critical and under-recognised gap in antenatal care: the lack of information provided to pregnant women about correct seatbelt use, despite motor vehicle crashes accounting for up to three-quarters of all trauma experienced during pregnancy. Evidence from North America shows that substantial improvements in correct seatbelt use can be achieved when antenatal clinicians are equipped with effective communication tools, demonstrating the potential for similar gains in Australia. Our findings reinforce the urgent need to strengthen antenatal care guidance, as pregnant women regularly engage with clinicians who are well-positioned to deliver this essential safety advice in a scalable trusted pathway.

Implications for policy and/or practice

These findings highlight the need for a more systematic approach to ensuring pregnant women receive accurate guidance on correct seatbelt use. We identified a lack of awareness among pregnant women regarding both the need for information and the availability of transport-related safety resources, suggesting that greater visibility and accessibility of this information is required not only within the health sector but also across broader transport and public-safety systems. Equally, we do not yet know what clinicians themselves know about this issue, although anecdotal experience suggests that clinician awareness and knowledge may also be low. If this low level of clinician knowledge is confirmed,

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it would further underscore the need for professional education. Together, these findings signal an urgent need for seatbelt-use guidance to be embedded in health-related policy, and routine antenatal care.

Table 2: Health related pregnancy information sources and seatbelt content

Information Source	Summary of Content	Mentions Seat Belt Use
NSW Antenatal Care	Focuses on routine antenatal health monitoring, screening, and pregnancy wellbeing advice.	No
NSW Health pregnancy related resources- refers people to "these trusted websites": https://www.pregnancybirthbaby.org.au	Focuses on range of pregnancy conditions. In the travel section "You should continue to wear your seatbelt during pregnancy. The lap sash of the belt should go around your hips and under your stomach. The shoulder strap should be above your stomach and between your breasts"	Yes
NSW Statewide Maternity & Neonatal Clinical Guidelines	Covers a broad set of clinical guidelines (e.g., labour induction, hypertensive disorders, infection, fetal growth).	No
Maternal & Child Health Primary Health Care Policy	Outlines frameworks for assessment, support, and primary health care delivery for mothers and infants	No
NSW Health Antenatal Care	Include options for care, shared care pathways, clinical guidelines, education topics (e.g., nutrition, warning signs)	No
Clinical business rule, Trauma in pregnancy, Royal Hospital for Women, 2017	In educational notes: "All pregnant women should be given information about correct placement of a seat belt. Lap belt should be positioned over hips and below uterus. Sash should be between breasts and above uterus"	Yes
RANZCOG Patient Info, Pamphlets, Common Questions, and Guidelines	Provides extensive obstetric and gynaecology guidance, patient pamphlets, common questions in pregnancy, and information on driving after abdominal surgery including caesarean section. No RANZCOG materials located that address pregnancy seatbelt use.	No
Patient information, Mothersafe, Travel in pregnancy	"In vehicles, make sure the seatbelt lap sash is worn across the hips and under your pregnancy bump while the shoulder sash should be fitted above your bump."	Yes

Conclusions

This work highlights a significant and previously under-examined gap in antenatal care in Australia: the near absence of guidance provided to pregnant women about correct seatbelt use, despite the well-established risks posed by motor-vehicle crashes during pregnancy. Our survey findings demonstrate that only a small minority of women receive this information, and a review of policy and guidance documents shows that seatbelt-use advice is not currently embedded in health pathways and guidelines. Together, these results point to a clear need for action to ensure that evidence-based safety information becomes a routine component of antenatal care. Strengthening clinician knowledge, enhancing the visibility of transport-related safety resources, and incorporating seatbelt guidance into health policy and clinical documents all represent practical, achievable steps to reduce preventable injuries and support safer outcomes for pregnant women and their babies.

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A participatory decision-making approach to generate demand for safe speeds

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Abstract
Shifting attitudes and perceptions about travel speeds and increasing demand for safer speeds is needed. This paper describes use and outcomes of a novel, participatory research approach (community jury) to deliver locally tailored, community-driven interventions targeting increased demand for safer speeds. In five New South Wales (NSW) local government areas (LGAs), community juries were held, consisting of 14-20 jurors each, representative of each LGA, based on Australian Bureau of Statistics data. Over 14 hours, jurors heard expert testimony, deliberated, and developed intervention recommendations (Phase 1). The research team and each LGA rated and ranked all intervention ideas. At least one jury recommendation has been implemented in each LGA (Phase 2). This paper describes the community jury method and outcomes, including jury-recommended intervention ideas, and community acceptance of the participatory approach.

Background
Traditional top-down approaches have not generated sufficient understanding of the risks of unsafe travel speeds, nor have they generated sufficient public demand for safe speeds (Fleiter et al., 2016). New approaches to dealing with these challenges are needed. There is increasing understanding that complex issues are better addressed through interventions co-developed with end-users, and mounting evidence of effectiveness of interventions designed through participatory approaches (Leask et al., 2019). Participatory decision-making methods are emerging as a promising method in other public health areas to generate community-driven solutions (e.g. see Braunack-Mayer et al., 2010). Community juries (or citizen juries) are a form of participatory decision-making that can facilitate communication of complex evidence required to elicit informed community perspectives (Street et al., 2014), and effectively shift attitudes to complex issues (Carman et al., 2014), and generate recommendations for intervention development using co-design principles (e.g., Coppell et al., 2020). Like a criminal jury process, the approach involves recruiting a group of people (jurors) representing community diversity and presenting them with evidence about the nature of a problem from experts who can be cross-examined prior to jury deliberations. To address the need for new approaches to increase community demand for safe speed, we examined the potential use of community juries as a mechanism for developing informed, community-driven interventions. The abstract aims to (i) describe how the community jury method was used to generate interventions tailored to local contexts in five NSW LGAs, and (ii) present qualitative findings on community acceptance of this method[1].

Conference theme – From Evidence to Action: Shaping a Brighter Future
This work directly aligns with the conference theme by demonstrating an innovative approach to transforming evidence into action through the participatory mechanism of community juries. By enabling diverse community members to interrogate expert evidence on safe travel speeds and deliberate on its implications, the process supports the development of locally tailored, community-driven interventions. In doing so, it provides a clear pathway for converting what we *know* about safe speeds into key messages that can build public demand for safe speed across different communities. Central to this is engagement of the community as key stakeholders in shaping road safety solutions, fostering a sense of urgency around the need for safe speeds, and identifying effective strategies to educate and persuade the broader community, leaders, and influencers about this issue.

[1] The *Education and awareness for safe speeds in communities* project was funded by the Australian Government through the Department of Infrastructure, Transport, Regional Development, Communications and the Arts.

Method

Participants and Recruitment

Juries were constructed using purposive sampling for five NSW LGAs (two regional, three metropolitan): Mid-Western Regional Council, Port Stephens Council, City of Canterbury Bankstown, City of Sydney and City of Coffs Harbour. The aim was to recruit a representatively diverse jury in each LGA of 20 people aged 18+ years who lived, or worked in, or regularly travelled through the LGA, matching pre-determined socio-demographic quotas based on Australian Bureau of Statistics data. Road Safety Officers distributed recruitment information and researchers contacted individuals who expressed interest via a project website. Participants were reimbursed $40/hour for time attending jury sessions.

Procedure

An expert in deliberative engagement and co-design processes was engaged to facilitate each jury (4 sessions totalling 14 hours/LGA). The jury remit was to consider and respond to three questions:

1. How can we achieve acceptance of, and generate demand for, safe speeds?
2. What is the most useful and compelling information for increasing understanding about safe speeds?
3. What do you believe are the most effective ways to create shift in public attitudes toward safe speeds?

The first three jury sessions (Session 1 = 2 hours, Sessions 2 & 3 = 5 hours each) were conducted in-person and final jury sessions (2 hours) were conducted online. A core group of technical experts plus 2-4 local experts specific to each LGA (e.g., crash survivor, first responder, police officer, Emergency Dept physician, Council roadworker, and safer streets advocate) presented evidence (see Table 1), allowing time for facilitator-led cross-examination by jurors, juror self-reflection and deliberation.

Table 1. Main topics presented to juries by core group of technical experts

Summary of the research aims; jury process and remit; and reasons why the research is needed
Global and local burden of road crashes and co-benefits to managing speeds (apart from safety)
Role of speed in crash causation and crash severity; impact speeds; human tolerance to force; the concept of safe speeds; stopping distances when travelling at various speeds in wet and dry conditions (including an interactive stopping distance estimation activity)
Behaviour and attitudinal change - current (national and NSW) community attitudes to speeding, current travel speed compliance rates in NSW; road safety messaging and communications overview
Evidence-based approaches to manage speeds: infrastructure, enforcement approaches, vehicle technologies
Speed limit setting principles and practices; Examples of creating public demand
Busting myths and misperceptions about speeding

The facilitator assisted in framing final juror-generated ideas addressing the three remit questions and led jurors to reach consensus on ranking of suggestions, resulting in a list of intervention ideas that formed the basis of a jury report provided to each LGA. Once each jury concluded, the research team convened a 3-hour Intervention Development Workshop with each LGA team. Researchers presented the jury-ranked list of intervention ideas to the respective LGA team, as well as an additional list of the same ideas that had been rated and re-ranked by four road safety experts using APEASE criteria (**A**cceptability, **P**racticability, **E**ffectiveness {including cost effectiveness}, **A**ffordability, **S**pill-over effects and Safety, and **E**quity, adapted from Michie et al., 2014). Each LGA then selected an intervention that contained or was based upon at least one jury idea. Funds were made available to each LGA (AUD 25,000) to develop and implement interventions. As part of a larger process evaluation, focus group discussions and in-depth interviews were conducted with jurors and LGA teams to assess project delivery process and outcomes, including acceptability and feasibility of this community-driven development process. Interventions and implementation plans for each LGA were summarised. Deductive coding guided by the Theoretical Domains of Acceptability (TDF, Sekhorn et al., 2017) was used to analyse transcripts. Seven TDF domains were examined to assess overall acceptability (Affective attitude, Burden, Ethicality, Intervention coherence, Opportunity costs, Perceived effectiveness, and Self-efficacy). Approval was granted by the University of New South Wales Human Research Ethics Committee.

Results

A representative sample of gender and age was achieved in four juries. In the remaining jury (Port Stephens), the older demographic was over-represented, and size ranged from 14-20 jurors. Retention rates were high across all juries; in one location, a juror withdrew during the second session and in another location, two jurors withdrew after the first session. High engagement was observed across all juries; many jurors voluntarily researched content and connected with community members or their local Road Safety Officer outside jury sessions. Juror reflections indicated a general lack of awareness of basic safe speed principles, including those in traditional media campaigns (e.g., safe stopping distances, increased crash risk with small increases in speed). Outcomes from each jury included a report containing a ranked list of juror-generated recommendations to generate public demand for safe speeds (10-13/jury). At least half the recommended ideas were deemed feasible and within scope by researchers. The five LGA-selected interventions were:

i) Personalised garden signs displaying individual residents' rationale for supporting safe speeds; ii) a 'Local Voices' competition inviting residents to create visual/audio content about why safe travel speeds are necessary using local stories; some were displayed on roadside signs and a public event showcasing two crashed vehicles from Transport for NSW Crashlab; iii) a campaign centred on 'Slow the F*st Down, thanks Coffs Harbour' with roadside signage and interactive public events and media activities (radio, social media, bus advertising), iv) a campaign of messages about safe travel speeds using VMS signage (targeting vehicles), Corflute signage (targeting pedestrians), and a website directing people to Transport for NSW Road Safety Learning Lab online resource; and v) a social media campaign filmed using local LGA residents and targeting myths and misperceptions about speeds and speeding.

Qualitative analysis demonstrated high degree of acceptability across communities. LGAs described the importance of research participation (Affective attitude -*Don't mind any attempt to tackle speeding-why the hell not? Let's do something, shake people up*) even with additional unpredictable workloads (Burden- *wouldn't describe this as effort-fits right into what RSO should be doing*). Juror responses indicated appropriate representation (Ethicality -*Broad spectrum of jurors, fair selection process*) and described some positive behaviour change post-jury (Perceived effectiveness and self-efficacy - *Great process to implement community initiatives. I was someone who'd always be 5ks over. After jury, I understand speed limits are there for a reason. I explain this to my family, based on research*). Initially, despite not knowing the content/direction of jury ideas, LGAs worked to match jury expectations with practical intervention delivery (Intervention coherence -*councils are quite risk adverse, we had to make sure that while paying homage to jury ideas, we're also working within our boundaries, within acceptable spaces to deliver something to resonate with community*).

Benefits to road safety

This research offers insight into employing a novel methodology to assist communities to understand complex road safety issues and help devise local solutions via a participatory decision-making process. High levels of participation and commitment to the task were observed in all juries, providing a level of confidence in this community-driven engagement process to enhance engagement with complex road safety issues.

Implications for policy and/or practice

Jury-generated ideas offer a novel way to translate evidence into local action and strengthen shared responsibility for road safety. The next research phase will assess intervention outcomes through a controlled difference-in-difference analysis of change in travel speeds and attitudes, pre- and post-implementation. Regardless of the outcome, current findings show the community jury method is a feasible approach to shared decision-making and intervention design, with potential relevance to other complex road safety challenges. The process revealed how communities understand safe-speed concepts and how different forms of evidence resonate. Overlap in jury ideas (e.g., the value of exposing the community to in-depth safe speed information to address key misconceptions) highlights the need for more effective ways to communicate complex information across communities. Unimplemented ideas remain available for future LGA consideration. Notably, many jurors expressed interest in ongoing involvement with their Road Safety Officer, with some willing to form local action groups, suggesting this approach may help LGAs build broader community ownership of road safety.

Conclusions

A community jury approach was used to develop informed, community-driven interventions tailored to local contexts to increase demand for safe speed across 5 regional and metropolitan NSW. The approach was found to be highly acceptable across all involved communities. Findings demonstrate that community-led approaches can be used to tackle complex road safety challenges, including enhancing awareness about the importance of safe speeds, and that such methods may be useful in building shared responsibility for road safety more broadly.

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PEDSat: using Artificial Intelligence to assess pedestrian safety risk at scale

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Abstract
In NSW, approximately ten pedestrians are killed or seriously injured each week. Pedestrians account for around 15% of road deaths. Despite significant available investment for pedestrian safety, there is no consistent analytical capability to assess pedestrian risk at scale. This paper presents PedSAT (Pedestrian Safety Assessment Tool), an artificial intelligence (AI)-based model designed to assess pedestrian crash risk at scale. PedSAT uses crash history, road characteristics, built environment data, land use and demographic variables to identify locations with elevated pedestrian risk. The model has been trained and tested using spatial datasets in NSW, and validated through holdout testing, demonstrating predictive accuracy of 70–75%. The results show that AI-based approaches can identify latent pedestrian risk before serious crashes occur and support more proactive, evidence-based investment decisions. PedSAT provides risk maps, ranked locations and explainable drivers of risk to assist transport agencies and councils in prioritising safety treatments.

Introduction
Pedestrian trauma remains a significant road safety concern in Australia. In NSW, pedestrians account for approximately 15% of road deaths and around ten pedestrians are killed or seriously injured each week. Nationally, pedestrian fatalities have increased in recent years and are currently at their highest level in more than a decade.

Governments continue to invest heavily in road safety. NSW alone is expected to invest approximately $2.8 billion in road safety programs over the next four years, with around $1.4 billion of this investment likely to influence pedestrian outcomes either directly or indirectly. However, the analytical tools available to support pedestrian safety investment remain limited.

Traditional approaches rely heavily on historical crash records, localised audits and professional judgement. While these methods remain important, they do not provide a consistent capability to assess pedestrian risk across entire networks or identify latent risk at locations where serious crashes have not yet occurred.
PedSAT (Pedestrian Safety Assessment Tool) was developed to address this gap by applying artificial intelligence and machine learning techniques to analyse pedestrian risk across the road.

Conference theme
This work supports the conference theme by demonstrating how advanced data analytics and artificial intelligence can translate complex safety data into practical decision-support tools for governments. PedSAT converts large and diverse datasets into clear, actionable insights about pedestrian safety risk. By identifying high-risk locations and the environmental factors contributing to risk, the model provides evidence that can inform infrastructure investment, safety programs and policy decisions. In doing so, the work demonstrates how emerging analytical methods can help translate evidence into targeted road safety interventions.

Method
PedSAT applies machine learning techniques to predict pedestrian crash risk across road networks. The model integrates multiple sources of spatial and transport data, including:

- pedestrian crash records
- road geometry and intersection characteristics
- speed environment and crossing infrastructure
- surrounding land use and pedestrian attractors
- demographic characteristics

High-resolution spatial datasets are used to capture the physical and environmental characteristics of the urban environment. Computer vision and deep learning techniques analyse spatial imagery and network features to identify patterns associated with pedestrian crash risk.

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The model compares thousands of locations where pedestrian crashes have occurred with locations where crashes have not occurred. This allows PedSAT to identify the environmental and network characteristics most strongly associated with pedestrian risk.

PedSAT has been tested using datasets from several NSW local government areas, including Hornsby, Waverley and Randwick. Model performance is validated using a holdout testing approach in which part of the dataset is excluded during training and then used to test predictive accuracy.

Findings

Initial validation results indicate predictive accuracy of approximately 70–75%, demonstrating the model's ability to identify locations with elevated pedestrian crash risk. This is expected to rise as the model is used more widely, and trained on more data.

PedSAT produces several practical outputs for transport agencies and local councils, including:

- network-wide pedestrian risk maps
- ranked lists of high-risk locations
- GIS-based heatmaps suitable for planning analysis
- explainable summaries of the drivers of risk
- scenario testing for potential safety interventions

A case study at the Derwent Street and Catherine Street intersection near Glebe Public School illustrates the model's application. The model estimated a pedestrian crash risk score of 0.15 prior to recent infrastructure improvements. Following installation of a raised pedestrian crossing and footpath widening, the estimated risk score decreased to 0.04, representing an approximate 70% reduction in predicted pedestrian crash risk.

These results demonstrate the potential for AI-based approaches to support proactive identification and treatment of pedestrian safety risks.

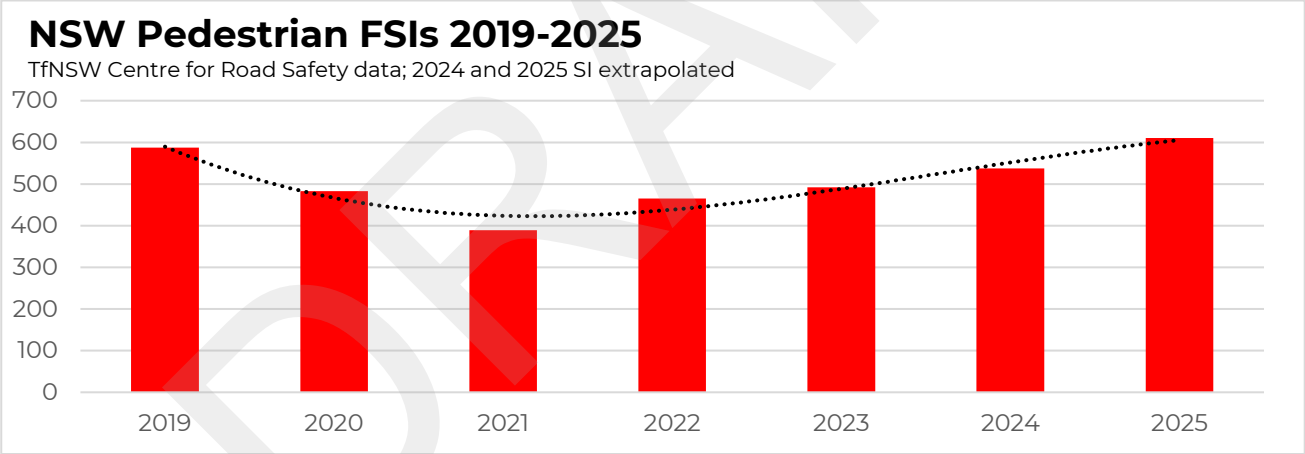

Figure 1 - NSW Pedestrian Fatal and Serious Injuries 2019-2025, NSW Centre for Road Safety 2025

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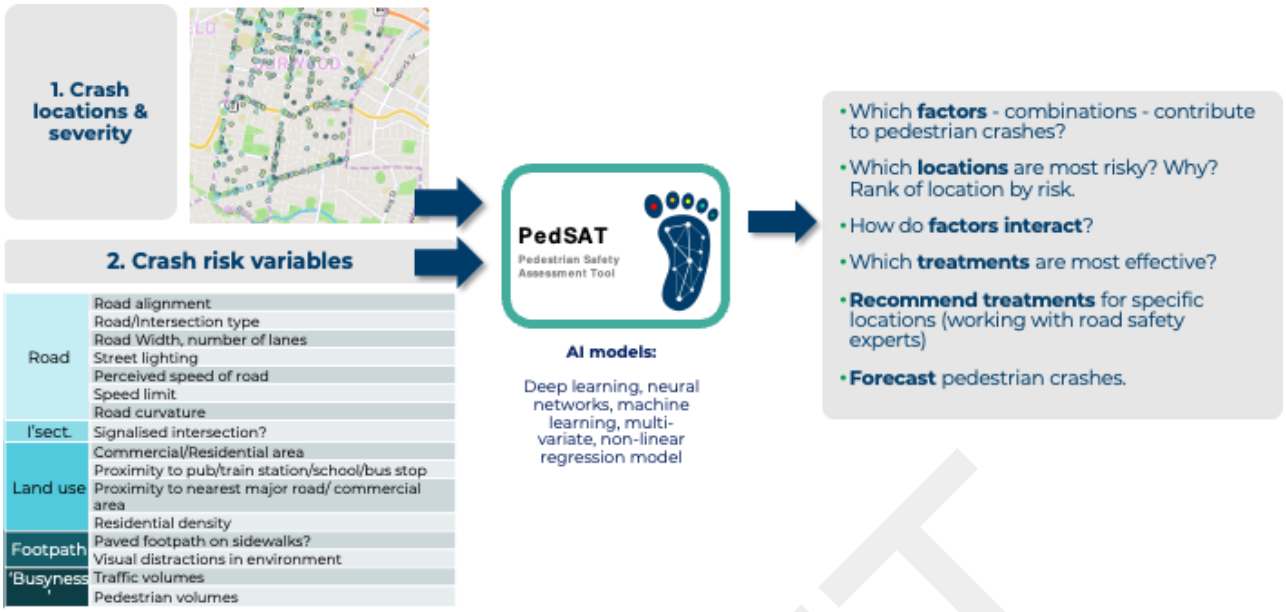

Figure 2 - PedSAT overview

Benefits to road safety

PedSAT provides several potential benefits for road safety decision-making:

- Earlier identification of locations with elevated pedestrian risk before serious crashes occur
- Improved prioritisation of safety investment across road networks
- Greater transparency in the drivers of pedestrian risk
- Stronger evidence to support grant funding and program evaluation
- More targeted infrastructure treatments addressing the underlying causes of risk

By enabling network-wide risk assessment, the tool supports a shift from reactive crash response toward proactive risk management.

Implications for policy and/or practice

The findings suggest that artificial intelligence can complement existing road safety methods such as crash analysis and road safety audits. For government agencies and local councils, PedSAT provides a structured analytical framework that can be integrated into existing planning, funding and governance processes. Risk maps and ranked locations can help guide the prioritisation of safety interventions, while explainable model outputs allow practitioners to understand the environmental factors contributing to risk. This capability has potential to strengthen the evidence base supporting pedestrian safety programs and improve the efficiency of safety investment.

Conclusions

PedSAT demonstrates the potential for artificial intelligence to support more proactive pedestrian safety management. By analysing large spatial datasets and identifying patterns associated with pedestrian crashes, the model can assess pedestrian risk across entire road networks and identify locations where intervention may be most beneficial.

Initial testing indicates strong predictive performance and the ability to generate practical outputs for government agencies and local councils. AI-based tools such as PedSAT can complement traditional road safety approaches by providing network-wide insights into pedestrian risk and helping translate data into targeted safety actions. Continued development and application of these methods may support more effective strategies to reduce pedestrian trauma.

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Steer clear: applying behavioural science to community safety

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Abstract
For decades, emergency services have urged drivers not to enter floodwater, yet vehicle related incidents remain the leading cause of flood fatalities. Traditional safety messages have not shifted behaviour at the scale required and related incidents remain the leading cause of flood fatalities. This presentation explores the design of **Steer Clear,** an emotive behaviour-change campaign developed and launched in late 2025. Grounded in behavioural science, the campaign challenges long-held assumptions about community safety communications. Drivers and their associated undesirable habits were examined, allowing materials to be developed that promoted a desirable behaviour that resonates, motivates and reduces risk. Behaviour change tools and methodologies used were unpacked, including how the COM-B model shaped both creative development and media strategy. Research inputs included rescue hotspot data and interviews with experts in the space. Place based engagement activities ran alongside the media campaign, providing local relevance and deeper community connections.

Background
A growing number of studies have revealed a trend in innocent bystander deaths resulting from the reckless behaviour of drivers.

In Australia, vehicle-related flood fatalities account for a large percentage of flood related deaths, with over 60% occurring in vehicles. Most of these involve men over 30 years old, often accompanied by female passengers and children. While double the number of drivers lose their lives than passengers, female passenger's deaths are proportionately higher, and children make up almost half the number of passenger fatalities.

Various media campaigns in the past have not reduced these numbers significantly. The Steer Clear campaign is designed around evidence-based behaviour science, aimed to reduce the number of fatalities and rescues by reframing messaging and focusing on high-risk areas with contextualised delivery methods.

Conference theme
Steer Clear – using behaviour change methodology to increase driver safety.

Project description
Despite repeated warnings, many people continue to take risks by driving into floodwater. The Steer Clear campaign seeks to challenge this behaviour and reframe everyday decisions behind the wheel by encouraging drivers to not get swept up in the moment and turn around and find another way.

Research sources for the Seer Clear campaign included peer-reviewed papers and articles, grey literature and expert interviews.

The main theme that surfaced from desktop research and interviews was the desire and urgency to reach a destination using a familiar route. In a high-stress situation such as during a flood, there is potential for cognitive overload to impede rational decision-making, e.g. deciding on the best way home.

The COM-B model of behaviour change was adopted for the campaign. The framework proposes three necessary components for any behaviour (B) to occur. Through assessing capability (C), opportunity (O) and motivation (M), we were able to understand why a specific driving behaviour occurs and how to create targeted interventions. Creative assets were based on the Com-B model, with *'Head'* messaging addressing inflated driver **capability**, **opportunity** and **behaviour** reflected in campaign audio and print messages ('*He just needed to pick up his son'* and '*He knew the road…*') and reflective **motivation** the overall campaign theme, addressing consequences of irresponsible driver behaviour and the impact on loved ones.

Implementation
The behaviour insights informed the campaigns creative development, which appealed to people's desire to protect. The approach pushed boundaries, flipping social norms and then following on with an alternative action they could take to avoid a disastrous outcome.

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An essential creative asset for the campaign was a video that conveyed the behaviour in the full context, incorporating all interventions, as well as delivering the emotion required to address complacency and the desire to protect loved ones.

For maximum effect, a realistic scene was created depicting a flooding car. No people are portrayed in the video, with the power of insinuation at play instead. The lighting, use of colour and props supported the serious tone to achieve the largest emotional impact.

In market deliverables

The Steer Clear media campaign ran between 19 October and 13 December, targeting the Sydney Metropolitan, Central Coast and the Illawarra communities of NSW.

Two messages were circulated during the campaign for emotive (heart) and logical (head) audiences.

- Head - *He knew the road, but he didn't know it was gone*
- Heart - *A moments impulse, a lifetimes regret*

Creative assets included print, radio ads and programmatic video ads, out of home, social media and a dedicated campaign webpage. The video was also hosted on YouTube.

Media assets included First Nations and CALD communities, with radio translations in Vietnamese and Arabic and broadcasts on Indigenous community radio stations and NITV after research indicated that these communities were prevalent in the campaigns target regions.

Community engagement programs ran to coincide with the media campaign in the hot spot areas.

Findings

Media

Channel	Impressions	Clicks	Reach	Video Views
Audio-Direct	374,893	N/A	174,771	N/A
Digital Out of Home	1,587,443	N/A	N/A	N/A
Video - Programmatic	723,059	270	449,869	711,910
Video – CALD	88,050	13	38,500	84,234
Social	3,584,187	5,165	887,771	10,895
Social - CALD	1,341,689	1,071	372,501	5,754
Total	**7,699,321**	**6,519**	**1,923,412**	**812,793**

The campaign achieved 7,699,321 impressions and reached an impressive 1,923,412 people across digital platforms ensuring the messaging was received by the targeted communities.

Whilst the measurement of behavioral science cannot be obtained in the short term, statistical data will be reviewed at 12 and 24 months post campaign to help inform campaign effectiveness. Consideration will be given to influencing factors such as frequency of flood events, proximity to rescue services, flood type and duration, and campaign delivery locations.

Community engagement

Face-to-face community engagement has been positive with flood rescue education and dirty water displays used to engage community. Local maps showing 'hot spot' flooding areas were used to provide community with relevant, local and practical information to make informed decisions when driving.

Benefits to road safety

To reduce flood-related fatalities caused by driver behaviour.

Implications for policy and/or practice

The campaign's reach of more than 1.9 million people and its strong engagement metrics indicate that reframing risk-taking behaviour in flood conditions can resonate with high-risk groups more effectively than traditional warning messages.

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Implications for policy

- Potential for behavioural-science frameworks to become standard practice in road-safety communications.
- Risk communication policy could shift from generic warnings to targeted, context-specific messaging.
- Integration of community engagement into official emergency and road-safety strategies. Policy could embed community-level activation as a mandatory complement to mass-media campaigns during high-risk seasons.
- Strengthening cross-agency collaboration for unified driver-risk messaging.

Implications for practice

- Evidence-based behaviour change models and methodologies continue to guide creative development to develop effective campaigns to maximise community impact.
- Creative execution must reflect realism without exploiting trauma. Two-track messaging (emotive + logical) significantly broadens audience reach.
- CALD and First Nations inclusivity is essential for equitable safety outcomes.

Conclusions

With engagement of close to 2 million people over an 8-week period, the Steer Clear campaign demonstrates the need for more behaviour change campaigns to reduce driver related fatalities on our roads. Repeat campaign messaging with wider network distribution would increase driver awareness and improve safety.

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Incorporating maintenance lifecycle improvements into Road Safety Action Plans

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Abstract
Road safety on managed motorways has traditionally depended on major upgrades or isolated safety projects, often missing opportunities embedded within routine maintenance. This paper presents an implementation case study of a novel approach where a managed motorway operator embedded Safe System principles into routine maintenance and renewal activities. Following an organisational restructure that created clearer asset ownership, Road Safety Action Plans (RSAP) were transformed from standalone initiatives into an enterprise-wide framework. A systematic review of over 200 planned maintenance activities led to the integration of safety enhancements across six Asset Lifecycle Management-aligned focus areas. A digital dashboard was developed to consolidate all RSAP tasks, providing real-time visibility of progress, evaluation metrics, and performance trends. Early outcomes demonstrate enhanced national consistency in safety planning, sharper hotspot targeting using a blend of crash and connected vehicle data, and accelerated delivery of safety benefits by bundling works.

Background
Improving road safety performance on complex managed motorway networks has traditionally relied on major infrastructure upgrades, isolated safety improvement projects, or reactive responses to emerging crash trends. While these approaches remain important, they often overlook the opportunity to enhance safety outcomes by refining maintenance activities rather than delivering like-to-like replacements. Embedding a road safety lens into routine maintenance enables small, systematic adjustments, such as improved material selection, enhanced delineation treatments, or smarter sequencing of works that collectively deliver measurable safety uplift without adding major capital investments.

A managed motorway operator recently implemented a change in operating model, featuring clearer asset ownership, integrated delivery teams, and outcome-based performance expectations. This created a unique opportunity to embed its Safe System aligned Road Safety Action Plans (RSAP) across a broad range of organisational activities, rather than have them function as a standalone program. The result is a shift from treating road safety as isolated initiatives to positioning it as an enterprise-wide mindset, activated through planned maintenance and renewal works to deliver faster, scalable and lower cost safety improvements.

Conference theme
This work strongly aligns with the ARSC 2026 theme From Evidence to Action, supported by contemporary guidance (Austroads, 2010; Austroads, 2025). The RSAP operationalises these principles by converting evidence, such as crash data, operational incidents, connected vehicle indicators, customer insights and asset conditions into practical enhancements delivered during planned maintenance and renewal activities. In doing so, it demonstrates how best-practice management frameworks can be translated into everyday operational decision making.

Method
This implementation case study documents the methodology for integrating safety into asset lifecycle management. A review of more than 200 planned maintenance and renewal activities across Australian assets identified opportunities to integrate road safety improvements. Through structured assessments and cross-functional workshops, over 30 tasks were refined into six Asset Life Cycle Management-aligned road safety focus areas for actions:

1. Pavement condition and skid resistance
2. Lane guidance and delineation
3. Forgiving roadsides and protective systems
4. Lighting adequacy
5. Driver information and way finding
6. Detection and response capability

Tasks were co-developed with asset engineers, road operation and maintenance delivery engineering and customer and public affairs teams. This evidence-informed approach guided prioritisation discussions and helped refine tasks. The evaluation framework is designed for monitoring of interim indicators and long-term outcomes. For each task, specific indicators and outcomes were defined, drawing from multiple data sources. Detailed evaluation of each task is ongoing.

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The intent was to ensure that maintenance driven enhancements were grounded in available evidence, even where the depth of supporting data varied across assets.

A dedicated Tableau dashboard was developed to consolidate all RSAP tasks into a single, real-time platform. This dashboard tracks,

- Activity progress
- Budget allocation and expenditure
- Location, asset, and region-based safety opportunities and visibility
- Evaluation metrics
- Emerging risks and delays
- Year-on-year performance trends.

This digital tool enables transparent reporting, continuous learning, and evidence-based decision making for future RSAP cycles.

Findings

Implementation and early progress

Early outcomes include:

- Enterprise consistency: One national RSAP framework now replaces fragmented, region-specific approaches
- Sharper targeting: Crash risk profiling further informs routine and major lifecycle-based maintenance near focused hotspots (late diverges, wet-weather crash sites, back of queue zones)
- Evaluation capability: Every task carries defined safety metrics to enable evaluation, supported by dashboard reporting.
- Faster delivery: Enhancements can bundle into planned closures reducing the need for new capital programs and bring forward safety benefits, including keeping roadworkers safe
- Capability uplift at scale: Engineers, operators and delivery engineering teams are actively applying a ‘Safe System’ safety lens, supported by new data tools and training (e.g. Connected vehicle data analysis)
- Stronger collaboration: Five months of cross team engagement – Asset engineers, operations, project managers and communications has created shared ownership of safety outcomes
- Dashboard-enabled insights: The Tableau dashboard has helped to identity opportunities with funding gaps, and highlights acceleration opportunities for high impact tasks – supporting data driven re-prioritisation

Case examples (Evidence to Practical action):

1. Road works speed compliance monitoring during re- surfacing programs: Connected vehicle analytics pinpoint low speed-compliance locations and times during long term pavement resurfacing and line marking projects. Interventions such as portable variable message signs, refined messaging, and coordinated enforcement led to improved speed compliance, fewer abrupt braking events and stronger customer perception of traffic control clarity.

2. Modernising detection and response - CCTV and Automatic Incident Detection camera upgrades: Upgraded CCTV and Automatic Incident Detection camera systems improve coverage, visibility and reliability. Integration with refreshed operational management control systems enables earlier incident detection and response through reduction in average detection times, quicker actions to manage speeds, utilise tunnel and open road messaging systems, address congestion and reduce primary crash risk and secondary-crash exposure. Richer safety-related data are also captured.

3. Civil maintenance as a proactive safety mechanism: Routine civil maintenance works are reframed as targeted safety interventions, for example, bollard upgrades, enhanced containment and roadside protection along heavy-vehicle corridors, Level 2 inspections and rectification of service pits, removing surface hazards affecting motorcycles and light vehicles, strengthening overall asset resilience.

Next steps: Improvements from regular reviews of operational activities will also be embedded into the RSAP, enabling earlier identification of crash reduction opportunities and improved network throughput. Deeper integration across asset maintenance portfolios, asset and network operations and network performance teams will expand the pool of actionable safety opportunities and continue maturing the enterprise-wise road safety mindset.

Benefits to road safety

Early organisational benefits include a stronger safety culture, uplifted technical capability and improved integration of safe system thinking into routine engineering, operations and maintenance decision making. These cultural and capability shifts create the foundation for sustained safety improvements as the program matures.

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The RSAP therefore represents significant potential to lead to improved safety outcomes through better skid resistance, enhanced delineation, more reliable driver information, improved night-time visibility and strengthened detection and response systems; benefits that will be validated through future evaluation cycles.

Implications for policy and/or practice

Practical implications for road operators and policymakers:

- Safety-by-default standards: Explicitly consider road safety in maintenance standards, scopes and project decision making gates.
- Data-informed prioritisation: Integrate crash, speed volume, occupancy, operational (including crash) and connected vehicle data for routine planning and evaluation
- Leverage planned major closures as strategic opportunities to conduct targeted safety improvements.
- Digital performance management: Adopt enterprise-wide dashboards for transparent monitoring, budget traceability and continuous improvements.
- Capability and culture: Invest in training, playbooks, and cross-functional governance to embed Safe System thinking in day-to-day engineering and delivery.

Together these practices enable more effective and efficient road safety delivery and more effective evaluation in resource-constrained environments.

Conclusions

An Asset lifecycle integrated, change management led RSAP converts evidence into action by harnessing planned maintenance and renewal activities to deliver low-cost, high impact road safety outcomes at scale within a managed motorway organisation. The approach accelerates delivery, strengthens collaboration, uplifts capability, and improves customer safety and network resilience and performance. It demonstrates that safer roads can be achieved not only through major capital investments, but also by reimagining how to maintain, renew, and operate the assets- supported by road safety and data-driven decision making.

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DRAFT

Designing for compliance: practical lessons in automated enforcement

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Abstract
Automated enforcement has become a central component of modern road safety strategies, with strong evidence demonstrating its effectiveness in reducing high-risk behaviours such as speeding, red-light running, illegal mobile phone use and seatbelt non-compliance. While the safety benefits of automated enforcement are well established, less attention has been given to the practical design and implementation factors that influence whether programs achieve sustained safety outcomes, operational integrity and public legitimacy. Automated enforcement programs are complex socio-technical systems rather than simple technology deployments. Jurisdictions seeking to introduce or expand programs must address issues including policy alignment, program scale, governance arrangements, operational capability and community acceptance. Drawing on practitioner experience in the development and delivery of automated enforcement initiatives in Australia, this paper presents a practical framework for designing effective, credible and defensible programs. The framework highlights key considerations in policy alignment, road safety management, offence-specific program design, public communication and risk management to support sustained reductions in road trauma.

Background
Automated enforcement has become an essential component of effective road safety strategies, with strong evidence demonstrating its effectiveness in reducing high-risk behaviours such as speeding (Wilson et al., 2010), red-light running (Høye, A., 2020), illegal mobile phone use (Lovesey et al., 2023), and seatbelt non-compliance (Lovesey et al., 2025). Evaluations across multiple jurisdictions show substantial and sustained safety benefits from these programs.

However, the successful design and implementation of automated enforcement programs is not simply a matter of replicating existing models. Programs operate within complex policy, operational and social environments. Jurisdictions seeking to introduce or expand automated enforcement frequently encounter challenges relating to program scale, governance, community acceptance and operational delivery.

Replicating programs without adapting them to local contexts and understanding social licence can undermine both effectiveness and public confidence. As automated enforcement expands into new offence areas and technologies, there is increasing value in sharing practical lessons on how programs can be designed to achieve sustained safety outcomes.

Conference theme
This paper demonstrates how practical lessons regarding the design of automated enforcement in the areas of policy alignment, implementation practices, communications and risk management can support road safety outcomes consistent with the Safe System objective of eliminating deaths and serious injuries on our roads.

Project description
Drawing on practitioner experience in the design and implementation of automated enforcement initiatives, this paper examines the key factors that influence whether programs succeed, stall, or fail to realise their intended safety outcomes. Implementation failure can be minimised by actively considering well established approaches to road safety management (Austroads, 2025). It presents a structured framework identifying the critical elements required to develop effective, credible and defensible automated enforcement programs.

Findings

Framework for effective, credible, and defensive automated enforcement programs
Figure 1 illustrates key aspects that influence the successful design and implementation of automated enforcement programs.

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Figure 1. Key aspects to design an automated enforcement program.

Aligning policy objectives with enforcement design, scope, and deployment strategy

The commencement of an enforcement program represents a critical stage in its lifecycle. At this point, jurisdictions must establish a credible rollout strategy that considers the operational value chain required to support enforcement activities. This is particularly important for mobile enforcement models where enforcement capability must be distributed across multiple locations and often requires multiple delivery partners both across key government delivery partners and procurement arrangements for deployment with the private sector.

Fixed enforcement programs are often designed to address specific high-risk locations. For example, red-light speed cameras treat signalised intersections and fixed speed cameras treat specific sections of roadway. In these cases, program scale and site selection should align clearly with the intended localised safety outcomes.

Programs seeking to achieve broader network-wide deterrence such as mobile speed cameras or trailer-based enforcement targeting mobile phone and seatbelt offences require sufficient operational capability to deploy enforcement across a wide range of locations. This requires careful consideration of trauma distribution, site suitability and organisational capacity to identify and operate appropriate enforcement locations.

Road safety management

Automated enforcement programs should be designed, implemented and evaluated within the broader context of road safety management and the Safe System approach.

Institutional management functions are particularly critical because they provide the organisational capacity and processes that translate road safety strategy into effective interventions and results. Functions such as leadership, coordination, legislation and policy development, funding allocation, monitoring and evaluation, and stakeholder engagement create the conditions in which enforcement programs can operate effectively. These functions ensure clear roles and responsibilities across agencies, support evidence-based decision making through data and performance indicators, and provide mechanisms for accountability and continuous improvement. When these institutional capabilities are weak or fragmented, enforcement programs may suffer from poor policy alignment, inadequate resourcing, operational risks, or declining public trust. Strong institutional management therefore acts as the “engine room” of road safety delivery, ensuring that interventions such as automated enforcement are designed, implemented and refined in a way that consistently supports the goal of eliminating death and serious injury on the road network.

Adapting program models to different offence types and behavioural risks

Automated enforcement programs targeting different offences require tailored design considerations. A key principle is ensuring enforcement operates in a fair and transparent manner allowing drivers the opportunity to modify their behaviour. The primary objective is to improve compliance through iterative penalties rather than immediately sanction drivers with licence loss unless behaviour is persistently dangerous.

Speed enforcement has historically been the primary application of automated enforcement. The introduction of camera-based speed enforcement has required consideration of issues such as signage, enforcement tolerances, graduated penalty schemes and warning periods when introducing new enforcement types.

Newer enforcement technologies targeting mobile phone and seatbelt offences introduce additional considerations. These include multi-stage human review of captured images to confirm offences, opportunities for customers to request review of offences, and public education campaigns prior to new automated enforcement programs.

Building and maintaining public trust through communication and transparency

Public acceptance plays an important role in the sustainability of automated enforcement programs. Clear communication regarding program objectives, safety outcomes and enforcement practices helps build community understanding and legitimacy. While automated enforcement programs often enjoy strong public support, they can also attract organised opposition. Maintaining transparency regarding site selection, program objectives and safety outcomes helps protect programs from these pressures and maintain public confidence.

Managing implementation risks and operational complexity

The implementation of automated enforcement programs presents a range of operational risks. Programs are often introduced during periods of heightened road safety concern or political attention, which can create pressure for rapid

implementation. Accelerated timelines may result in reliance on existing systems or processes that are not designed for the scale or complexity of new enforcement technologies.

Effective implementation requires careful planning across the entire operational value chain, including technology deployment, image processing, offence verification, customer review processes and legal administration. Each element must be appropriately resourced and integrated to maintain operational integrity.

Maintaining the integrity and reliability of enforcement systems is critical to sustaining public trust and ensuring programs deliver intended safety outcomes.

Benefits to road safety

The framework presented in this paper highlights key considerations that influence program success and identifies risks associated with poorly designed or implemented programs, which if addressed are more likely to achieve behavioural and safety outcomes.

Implications for policy and practice

Achieving the full safety potential of automated enforcement requires deliberate program design focused on behavioural compliance rather than technology deployment alone. By translating practitioner experience into a structured framework, this paper provides practical guidance for policymakers and practitioners seeking to implement scalable and sustainable automated enforcement programs aligned with Safe System objectives.

Conclusions

This paper presents practitioner insights from the design and delivery of automated enforcement initiatives in Australia and provides a framework to support successful program implementation. Ensuring strong policy alignment, effective road safety management, transparent communication and robust operational practices is essential to maximise the ongoing contribution of automated enforcement to the goal of eliminating deaths and serious injuries on Australasian roads.

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DRAFT

Differences in risky driving behaviours in school and roadwork zones

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Abstract
School zones and roadwork zones share attributes of reduced-speed environments and are often associated with risky driving behaviour. This study investigated factors influencing risky driving behaviours in school and roadwork zones using self-reported data, including speeding, phone use, tailgating, hard braking and sign and signal violations. Online survey data collected from 719 drivers in Australia were analysed using multinomial logistic regression models. Results revealed that exposure, experience, and situational responsibilities shape driving behaviour in the specified zones. School pick-up/drop-off responsibilities significantly elevated risky actions within school zones. More frequent driving through roadwork zones was associated with a greater likelihood of speeding and phone use in roadwork zones. The findings suggest that risky behaviours are context-specific rather than uniform, providing an evidence base which emphasises the need for targeted interventions in these two critical areas of the road network.

Introduction
School and roadwork zones in Australia have reduced speed limits to protect people on foot who are likely to be crossing or be present close to traffic streams. Nonetheless, substantial contextual differences exist between school zones and work zones, which influence the risks and guide the relevant countermeasures and strategies for speed management and safety enhancement (Fleiter et al., 2016). At the core of this issue are driver perceptions, characteristics and behaviours, alongside the limited understanding of underlying factors that generate different outcomes in school zones compared to work zones (Wishart et al., 2022). Studies from Queensland, Victoria, and New South Wales indicate that 70-98% of drivers exceed roadwork speed limits, frequently by up to 30 km/h, but the level of speeding is comparatively lower in school zones (Debnath et al., 2014; Fleiter et al., 2016). In NSW roadwork zones, 93% of rear-end crashes were caused by speeding, and 72% involved at least one injury casualty.

Quality data on risky driver actions in school and work zones is only available for speeding, indicating that our limited understanding of work and school zone risks results from a lack of suitable, reliable data. In addition to speeding, there could be significant contextual differences between school and roadwork zones for other risky driving actions, such as mobile phone use, tailgating, hard braking and violating signs and signals (Garefalakis et al., 2024; Li et al., 2021; McCarty & Kim, 2024). A comparative investigation of school and roadwork zones can help reveal how contextual differences influence the likelihood of the occurrence of risky driving behaviours. However, these risky actions are not compared across the two high-risk temporary traffic management zones. Therefore, to address this gap, this study collected new data on risky driving actions, including speeding, phone use, tailgating, hard braking, and violating signs and signals, in school and roadwork zones to examine the differences in these risky actions between the two zones.

Conference theme
This study translates detailed behavioural evidence into actionable road safety insights by examining how risky driving behaviours vary across school and roadwork zones, driver characteristics and regions. The findings identify high-risk driver groups and regions (states and territories), highlighting where interventions are most needed. By linking these evidence-based insights to context-specific strategies, such as targeted enforcements, awareness and education programs, this work demonstrates how empirical understanding of driver behaviour can directly inform effective policy and practice to enhance the safety of people on foot in high-risk zones.

Method
A nationwide driver survey was distributed online between 15 August and 31 October 2025, collecting 719 valid responses. Driver demographic characteristics, travel behaviours, and the self-reported frequency of involvement in risky actions in school and roadwork zones were collected separately through the survey. Multinomial logistic regression models were applied for analysis. The dependent variable was the self-reported difference in frequency of the behaviour between school zones (SZ) and roadwork zones (RZ), coded as −1 (more frequent in RZ), 0 (same frequency across zones), and +1 (more frequent in SZ). Separate multinomial logistic regression models were estimated for each risky driving action. The base category for all models was equal frequency across zones (0). Independent variables included demographics, exposure measures, and situational factors hypothesised to affect behaviour in different zones. Relative risk ratios (RRRs) were reported to indicate the change in likelihood of reporting a higher or lower frequency

in one zone relative to the base category. This approach allowed assessment of the likelihood of zone-specific risky behaviour while accounting for differences in driver characteristics.

Results

Table 1 reports the Relative Risk Ratios (RRR) from multinomial logistic regression models for each risky driving action. The analysis revealed that the difference in driving behaviours between the two zones is influenced by driver characteristics, exposure, and responsibilities. The relationship between the dependent variable and the predictors is discussed for those that are statistically significant at 95% confidence level.

Table 1. Relative Risk Ratio (RRR) from the multinomial logistic regression for the difference in risky actions in school and roadwork zones (base category: no difference in behaviour across SZ and RZ)

Independent variables		Risky actions more prevalent in RZ					Risky actions more prevalent in SZ				
		Speeding	Phone use	Tail gating	Hard braking	Sign & signal violation	Speeding	Phone use	Tail gating	Hard braking	Sign & signal violation
Age group [Ref: 18-34 yrs]	35-44 yrs		0.6[a]		1.8[c]			0.6[a]		1.6[b]	
	45 yrs & over		-		-			-		-	
Gender: Male [Ref: Female]					0.7[a]					-	
Driving exp. [Ref: 6-10 yrs]	Less than 6 years	-	0.5[a]	-	-	-	0.2[c]	0.3[b]	-	-	0.3[c]
	More than 10 years	-	0.2[c]	0.3[c]	0.5[b]	0.2[c]	0.1[c]	0.2[c]	0.3[c]	0.4[b]	0.1[c]
Weekly driving distance			1.0[a]	1.0[b]		1.0[a]		1.0[b]	-		-
State [Ref: NSW]	WA, NT, ACT	-		-	-	-	-		-	-	0.6[a]
	QLD	0.4[c]		2.0[a]	-	-	0.3[c]		2.0[a]	2.0[a]	-
	SA	0.5[a]		-	2.3[b]	0.5[a]	-		-	2.9[c]	-
	TAS	-		-	2.1[b]	-	-		-	2.1[b]	-
	VIC	-		-	1.7[a]	-	-		-	2.1[b]	-
Driving frequency in SZ		-	0.8[b]				0.7[c]	0.8[b]			
Driving frequency in RZ		1.2[b]	1.2[a]				1.2[b]	-			
Worked in RZ and/or SZ			-			0.6[a]		0.4[a]			-
Pickup/drop-off responsibility		-	2.7[c]	-	2.3[b]		4.1[b]	4.0[c]	3.0[b]	2.9[c]	
Use ADAS feature(s)				-					0.9[b]		

[a,b,c] Significant at 90%, 95% and 99% confidence level, respectively
- Not statistically significant

The results showed that compared to younger drivers (18-34 years), middle-aged drivers were more likely to brake abruptly in both roadwork and school zones, relative to drivers who reported the same braking behaviour in both zones. In contrast, Montgomery et al. (2014) reported that drivers aged over 30 years tend to apply brakes early, utilising data from vehicles in a metropolitan area. This suggests that the driving behaviour can vary depending on the driving environment. Less-experienced drivers (<6 years) were less likely than those with 6-10 years of experience to report frequent speeding, phone use, and sign/signal violations in school zones, compared to reporting similar behaviour across both zones. This suggests that less experienced drivers exercise greater caution and adopt safer behaviours in high-risk areas. Notably, more experienced drivers (>10 yrs), compared to those with 6-10 years of experience, were less likely to be involved in risky driving actions in both zones. Significant differences in driving behaviours in roadwork and school zones were observed across Australian states and territories. Relative to similar behaviour across school and roadwork zones, drivers in Western Australia, the Northern Territory, and the Australian Capital Territory were less likely than those in New South Wales to commit sign/signal violations in school zones. In Queensland, drivers were less likely to report speeding in both zones, with a more pronounced reduction in school zones. Conversely, drivers in South Australia and Tasmania were more likely to report hard braking in both zones, whereas Victorian drivers were more likely to report this behaviour only in school zones. These differences across states and territories may reflect variations in regional traffic management and enforcement practices, road design and driver behaviour on Australian roads.

Drivers' travel frequency and situational responsibilities in specific zones were strongly associated with zone-specific risky behaviours. Higher driving frequency in roadwork zones was associated with increased speeding in both roadwork and school zones, while higher driving frequency in school zones reduced speeding in both zones and phone use in school zones. Further, drivers who had worked in roadwork or school zones were less likely to use a phone in school zones and less likely to violate signs and signals in roadwork zones, suggesting professional exposure encourages safer driving practices. Interestingly, having a pickup and drop-off responsibility for school-going children was consistently associated with a higher prevalence of multiple risky actions in school zones, including speeding, phone use, tailgating, and hard braking, possibly reflecting the influence of time pressure or task-related demands on driving behaviour. The

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effect was also translated to a higher likelihood of phone use and hard braking in roadwork zones. Finally, the use of advanced driver assistance system (ADAS) features was associated with reduced hard braking in school zones, suggesting that related technologies may help moderate certain risky actions.

Benefits to road safety

By identifying drivers more likely to engage in risky driving actions in school and roadwork zones, interventions can be targeted more effectively and enhance road safety. Tailored strategies, including awareness campaigns, behaviour-focused education, and supportive technologies such as the use of ADAS, can reduce actions where they are most prevalent, lowering crash risk and improving safety for all road users in these sensitive zones.

Implications for policy and/or practice

The results suggest that traffic safety policies should account for both driver characteristics and contextual factors. In school zones, targeted enforcement and educational programs could focus on drivers with child pick-up or drop-off responsibilities, who are more likely to engage in risky behaviour. In roadwork zones, interventions could emphasise context-sensitive warnings. The findings also highlight regional differences in driving behaviour across states and territories, suggesting that policies and interventions may need to be tailored locally. Integrating such evidence-based strategies into planning, enforcement, and driver support systems can enhance the efficiency and effectiveness of interventions across driving contexts and driver subgroups.

Conclusions

This study demonstrates that risky driving behaviours vary across school and roadwork zones and are influenced by driver exposure, experience, and situational responsibilities. Drivers with frequent roadwork exposure or school pick-up/drop-off duties are more likely to engage in zone-specific risky actions, while experience tends to reduce risky behaviours in high-risk environments. These findings highlight the importance of considering both individual and contextual factors when addressing traffic safety. Future research could investigate the effectiveness of targeted interventions, such as driver education, in reducing zone-specific risky driving actions.

Acknowledgement

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Influence of shared space design features on road users' safety

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Abstract
Shared spaces rely heavily on design features to differentiate from conventional roads and to guide safe interactions between road users. However, the empirical evidence on how these design features influence road user experience and interactions remains limited. This study investigated how road design elements influence user perceptions, driving behaviour, and road user interactions through undertaking an online safety perception survey, an observational analysis of road user interactions, and a driving simulator experiment. The results synthesised across the three studies identified design features, such as trees, seating spaces, and levelled surfaces, that encourage lower vehicle speeds, improve yielding behaviour, and promote safer interactions among road users. In contrast, some features, such as on-street parking spaces, negatively affect users' perceptions and behaviour. By integrating evidence from a comprehensive examination of road user dynamics, the study provides practical insights to inform safer, more effective shared-space design.

Introduction
Shared space is an urban design concept that encourages increased pedestrian and cyclist activity within low-speed environments shared with vehicular traffic. These spaces are generally characterized by a combination of different features, such as gateway treatments, street art, roadside furniture, and the absence of conventional traffic signs, signals, and crossings typically observed on roads. While shared spaces aim to improve safety for vulnerable road users (VRUs), many of them, especially pedestrians and cyclists, have safety concerns about sharing the space with other vehicles (Tzouras, et al., 2023). Furthermore, in the absence of traffic signs and signals and a defined right-of-way, the interactions between vehicles and VRUs become more complex and less predictable (Yao et al., 2025). Such uncertainty presents significant challenges to both operational and safety aspects of road user interactions in shared spaces. Therefore, it is essential to examine the dynamic influence of shared space design features on road users' perceptions, behaviours, and interactions within the shared environment. However, current safety analysis approaches often rely on users' perceptions, behaviour and interactions individually, but do not consider these aspects and their dynamics altogether. Despite many research investigating the perception and crossing behaviour of pedestrians (e.g. Karndacharuk et al., 2016; Tzouras, et al., 2023) and their interactions with vehicular traffic (Jakobowsky et al., 2021), limited attention has been given to a holistic understanding of perceptions of road users, driving behaviours, and the mechanisms of unsafe vehicle-pedestrian interactions in shared spaces. Therefore, this research aims to address this significant gap in the literature by examining the influence of several design features through a comprehensive examination of road user dynamics. This aim was achieved through an extensive investigation into road user perceptions, behaviours, and interactions within shared spaces using a multi-study mixed-methods approach, including an online road user perception survey, an observational study of road user interactions in shared spaces, and a driving simulation study of road user behaviour and interactions.

Conference theme
This study directly aligns with the conference theme by translating empirical evidence from multiple complementary methods into actionable insights for safer shared space design. By integrating findings from user perception surveys, real-world traffic observations, and controlled driving simulator experiments, the research provides robust evidence on how specific design features influence behaviour and interactions in shared environments. These results offer a clear pathway from evidence generation to practical interventions that can improve safety outcomes and shape shared space design.

Method
To achieve the research aim of a holistic understanding of the influence of shared space design features on road users' perceptions, drivers' behaviour, and their interactions with other road users in shared spaces, a mixed-methods approach was implemented across three research phases in a PhD research.

Phase 1: An online survey was conducted to understand road users' perceptions of design features commonly implemented in shared spaces. This survey collected data from 266 pedestrians, 183 drivers, and 108 cyclists, on their perceptions of safety, comfort, priority, and willingness to share and use the space. The survey data were analysed statistically using a three-stage least squares model to examine how design features of shared spaces influenced road users' perceptions of safety, comfort, priority, socialising, and willingness to share the space.

Phase 2: An observation study was undertaken to analyse driver behaviour and traffic conflicts between vehicles and pedestrians. Traffic movement videos of 66 hours collected from two shared spaces in Victoria were processed using a validate image processing tool to extract vehicle speeds, trajectories, and traffic conflicts. Multivariate left-censored Tobit regression models were employed to model speed limit compliance. Further, a generalised linear model was calibrated to investigate the factors influencing pedestrian-vehicle conflicts.

Phase 3: A driving simulator study involving 38 adult drivers provided data on driving performance (e.g. speed profiles) and interactions with pedestrians in shared spaces (e.g. yielding behaviour). Driver speed profiles at different areas of a shared space (i.e., entry, during interactions, midway, and exit areas) were analysed using a multilevel generalised linear model, and driver yielding behaviours were analysed using a mixed-effect multinomial logistic regression model.

The findings across the three phases were then synthesised to draw key insights on the influence of design features on road user dynamics, including perceptions, behaviours, and interactions with road users.

Findings

Several key insights are drawn from the research through a combination of studies regarding road users' perception, interactions, and drivers' behaviour in shared spaces.

Trees/planters and seating spaces

The perception survey revealed that both pedestrians and drivers felt more comfortable in shared spaces where trees were planted, and pedestrians were more willing to spend time in shared spaces that had seating areas. Additionally, results on drivers' speeding behaviour confirmed that vehicles tended to comply with the posted speed limits in the presence of planted trees and seating areas (Ghimire et al., 2026). Although no statistical significance was found in the severity of pedestrian-vehicle conflicts, the presence of a row of trees in shared spaces and the provision of seating areas offered multifaceted benefits, particularly in terms of road users' perceptions and drivers' compliance with speed limits. One can argue that, from a Safe System Approach (SSA) perspective, trees can act as roadside hazards, as collisions with fixed objects at high speeds can lead to severe injuries or fatalities (Austroads, 2024). However, in shared spaces, where vehicle speeds are inherently low, the risk of serious injury is significantly reduced. The presence of trees in shared spaces can indeed support the SAA principles by encouraging lower speeds and reducing the safety threat to all road users.

Posted speed limit signs

The investigation of road users' perceptions showed that pedestrians feel comfortable and are willing to spend time in shared spaces where low speed limit signs were posted. Additionally, the examination of drivers' speed profiles in five different sections of a shared space revealed that the speed of a vehicle reduces substantially throughout the shared space when a low speed limit sign is posted. Further, results on drivers' yielding behaviour indicated that drivers are likely to yield early and safely when a lower speed limit is posted in a shared space. Implementing a lower speed limit effectively reduces vehicle speeds, which in turn reduces the number of crashes and fatalities (Atkins et al., 2018). Finally, in shared spaces where the speed limit is not posted, the events where drivers do not yield to pedestrians will likely decrease, but the drivers tend to travel at a higher speed. This implies that in the absence of regulatory signs, drivers tend to become more attentive and engage more actively with their surroundings (Hamilton-Baillie, 2008). These findings suggest that implementing a low speed limit provides more safety benefits than removing the speed limit signs in shared spaces.

Levelled surface, street texture and street art

Analysis of drivers' speed profiles revealed that a shared space where the surface is levelled (i.e. removal of kerbs) and the surface pavement is textured significantly reduces drivers' speed throughout the shared space. Additionally, road users' perception outlined that pedestrians felt they had priority over vehicles and cyclists, and were willing to engage in social activities in shared spaces that had a levelled surface. Furthermore, pedestrians felt they had priority over vehicles in shared spaces where street art or patterns were present. Previous research showed that, if a road section felt different from a traditional road, it reduced the driveability of the space and promoted social cohesion and pedestrian use (Hamilton-Baillie, 2008). Taken together, these findings suggest that a shared space that looks like a non-standard road environment with no strict physical separation between road users creates ambiguity in drivers and encourages them to proceed cautiously, resulting in reduced speeds. Furthermore, these features also enhance the pedestrian experience, promoting a sense of priority over other users and increasing willingness to spend time in the environment.

Provision of a parking area

The results indicated that the provision of a parking area in shared spaces raised serious safety concerns. While the presence of a parking area in a shared space reduced the likelihood of drivers' non-compliance with the posted speed limit, road users' perception showed that pedestrians felt a lower priority over other road users when a parking area was provided in the shared space. When parked vehicles were present in shared spaces, pedestrians were likely to cross between parked vehicles. The results of the driver yielding behaviour model showed that the likelihood of drivers not

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yielding to a crossing pedestrian or yielding late, resulting in a traffic conflict, increased significantly when pedestrians were crossing between parked vehicles. Furthermore, the results on traffic conflict analysis revealed that the severity of a conflict increased when pedestrians crossed the street between parked vehicles. These findings suggest that while drivers are more likely to comply with posted speed limits in the presence of a parking area, the repercussion of this amenity poses a significant safety concern to pedestrians in terms of their perceived priority, vehicle yielding, and conflict severity.

Benefits to road safety

The findings identified many design features, such as posting low speed limit signs, removal of kerbs, use of textured paving materials, provision of trees/planters, and seating area in shared space, that had a positive influence on road users' perceptions, drivers' choice of speed, speed limit compliance, drivers' yielding behaviour and safe interactions between road users. Conversely, some design features, such as the provision of parking areas in shared space, negatively influenced pedestrians' perception of priority. More importantly, the ramifications of providing a parking area triggered a chain of safety concerns regarding vehicle speed, drivers' yielding behaviour, and conflict severity. By clarifying which design features support safer interactions, the study provides evidence to help reduce traffic conflicts and improve overall road safety performance.

Implications for policy and/or practice

These findings can significantly aid transport engineers, urban designers, and policymakers in strategically implementing the design features that positively influence road users' perception, interaction, and behaviour in shared space and ensure a safer environment for all road users. In Australia, the National Road Safety Strategy 2021–2030 highlights the need to strengthen the Safe System through safer road design and speed management, including the adoption of the Movement and Place approach, which recognizes streets as both transport corridors and public spaces where safe access and interaction for all users must be prioritized. The findings of this research contribute insights relevant to these national priorities aimed at improving safety outcomes in complex urban street environments.

Conclusions

Through a multi-study mixed-methods approach, this research provided a comprehensive synthesised evaluation of how shared space design features simultaneously influence user perceptions, road user behaviour, and interaction-based safety outcomes, addressing an important gap in the shared space literature. Design features, such as low speed limit signs, trees, and seating areas, offered significant safety benefits by encouraging lower vehicle speeds and promoting safer interactions among road users. However, parking areas in shared spaces were found to have safety concerns on perceived priority, vehicle yielding, and conflict severity. Finally, through an integrated approach to investigating road user dynamics, this research advances current knowledge and offers a solid foundation for future work in improving safety in shared spaces globally.

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The effects of lane width on crashes along straight two-lane two-way highways

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Abstract
Lane width is a key road infrastructure attributes that is associated with crashes two-lane high-speed roads. Despite numerous studies on this topic, the effects of lane width variations on crashes along two-lane high-speed roads are not well known, particularly for straight, undivided, two-lane high-speed roads. Taking a fixed length 1km segmentation approach, this study aims to investigate the relationship between lane widths and road traffic crashes along straight, two-lane roads. For this research, an extensive dataset comprising lane width information and traffic volume was extracted for 14,781 km of straight two-lane high-speed roads from Queensland's 34,758 km state-controlled road network. In addition, the injury crash records for 2015-2024 were extracted from Queensland's crash database. Negative Binomial Regression Negative Binomial regression models were developed for low-volume and high-volume roads to examine the relationship between lane width and crashes while controlling for exposure. The results indicate that lane width has a non-linear relationship with crashes on straight, two-lane high-speed roads. For high-volume roads, the relationship follows a convex polynomial curve, with a minimum crash rate occurring at a lane width of approximately 3.34 m. These findings reveal the non-linear nature of the lane width–crash relationship and provide important insights into the safety implications of lane width for road transport authorities.

Background[1]
Road crashes is one of the leading causes of premature death around the world with approximately 1.19 million people dying each year due to traffic related crashes (Lee et al., 2015; World Health Organization, 2023). This is only a fraction of the total number of crashes occurring, with fatal crashes comprising less than 2% of all casualty crashes in Queensland, Australia, the focus location for this study (TMR, 2025). Historically, wider lanes have been associated with safer lanes, noting that this varies depending on the width of shoulders (Zegeer et al., 1994). Zegeer et al. (1994) found accidents are significantly reduced by wider roadway, although the research was limited to foot increments in road widths and shoulder widths. Crash Modification Factor (CMF) functions for lane widths from the Highway Safety Manual (HSM) (AASHTO, 2010; 2014) indicates that crash rates increase with volume and decrease as lanes are widened. Subsequent studies found that non-linear CMFs were more appropriate for lane width crash risk, with 12 feet wide being found to be the highest risk (Lee et al., 2015). Lee et al. (2015) looked to develop modified CMFs, varying by speed limits, although a relationship with volume was not investigated and, as around 70% of the study's network was 12 feet wide, the lack of real-world narrower lanes was a limitation. Recent research has indicated this may not always be the case, with narrower and wider lanes found to be safest in a Norwegian study (Pokorny et al., 2020). Pokorny et al. (2020) looked at the segmentation of a large network, with attributes of lane width, shoulder width, curvature, volumes (light/heavy), lane length, speed limit, county, and crash type investigated to develop a model to predict crashes. Some limitations of this research were that lane widths were measured in 0.25m increments and shoulder widths were usually less than 1m wide. Applicability of this research to an Australian context might be limited due to the atmospheric differences between Norway and Australian as well as Norway's low crash rate.

This study aims to investigate the relationship between lane widths and crashes in 0.1m increments in lane width for two-lane two-way highways. Crashes on straight two-lane high-speed roads, not at intersections, are one of the key crash concerns, particularly for more severe crashes, comprising the majority of the road network and accounting for approximately 25% of all crashes in Queensland, Australia (TMR, 2025). Due to this large proportion of all crashes occurring on what is the common road type, there is a need to understand the factors that contribute to these crashes that can be influenced. The motivation for looking at the road cross-section geometry was due to the innovation and use of the Wide Centreline Treatment (WCLT) in Queensland, which led to improvements in road safety by narrowing a lane width from 3.50m to 3.25m, and shoulder widths by 0.25m, providing a 1.00m separation between opposing vehicles (Lian et al., 2025). This study looks to identify what relationships exist between 0.1m incremental cross section intervals of lane width, with uniform speeds, volumes and curvature, and the associated crash rates for different crash types and user types?

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Conference theme

This paper addresses the ARSC2026 conference theme of *From Evidence to Action: Shaping a Brighter Future* through the question of "What is the evidence telling us" and "How are we transforming evidence into action?". The collaborative research being undertaken into the effects of lane width on crash rates between the road jurisdiction and university will provide the evidence (the what) necessary to modify design guidance (the how). With the high cost of delivering infrastructure improvements, the ability to consider lane narrowing on existing road cross sections to reduce crashes in certain circumstances will transform our road networks.

Method

Regression modelling, specifically for a non-linear model, was determined necessary to model the crash risk relationships that exist in road safety infrastructure. Noting the research in this field has found that Poisson Distribution models may often be over-dispersed (mean not equal to variance) leading to a better fit when using a Negative Binomial model (Poch & Mannering, 1996). The focus though on a specific factor, of lane width, has meant that there is the risk of unobserved heterogeneity, the unmeasured differences that may exist that are not captured by explanatory variables. The use of road segments with the large number having zero crashes violates the distributional assumptions of a Negative Binomial regression model. The random parameters Sichel (S) regression model was selected to address excess zeros and unobserved heterogeneity, by employing multi-distribution variants to the model (Geedipally et al., 2012) although analysis did not occur at the time of publication for the NBL model. Comparison occurred with a Poisson regression model and a traditional Negative Binomial model to determine which empirical analysis approach was the best fit based on the Akaike Information Criterion (AIC), widely used as the measure of fit for model selection in the Bayesian paradigm.

The data used for this study is compiled from the Queensland State-controlled road network, in Australia, where it has been determined that the speed is high, the alignment is straight, the road is sealed, and there are only two lanes. This data capture takes into account 14,781km of the 34,758.1 carriageway kilometres of this network. 53,949 crashes occurred between 2015-2024 that ended with at least one road user being injured, of which 5,695 crashes occurred on the 14,781km's where the speed is high, the alignment is straight, the road is sealed, and is undivided with two lanes. A review of the number of crashes by AADT and by lane width indicated that there was not statistically significant data to determine results for volumes less than 300vpd or over 19,200vpd or for lanes that were less than 3.0m wide and over 3.5m. This data represents 5,155 crashes (90.5% of selected crashes) on 8,936km's (60.5% or selected length) of the original 14,781km of network. Multiple analysis runs indicate that there were three distinct lane width behaviours, occurring at low (up to 4,800vpd), medium and high (above 9,800vpd) volumes. Only 80% of the network was modelled, leaving 20% for validation.

Results

Having limited the analysis to only a proportion of the network with similar characteristics, the statistically significant variables in the crash prediction models, for low, medium and high volumes, were the natural log of the average annual daily traffic (AADT), the lane width (LW) and the LW squared. Analysis, shown below in Table 1, was undertaken using RStudio version 2026.01.1 Build 403 using Poisson, Negative Binomial and Sichel models to determine the most appropriate model to predict crashes per kilometre. The analysis indicates that the assumed convex and concave polynomial curves fit the data, with an unstable medium volume range, and have indicated that the apex of 3.14m at low volumes and 3.34m at high volumes, shown in Figure 1. The low volume results align with previous research, although for high volumes it is the reverse of what historically has been seen.

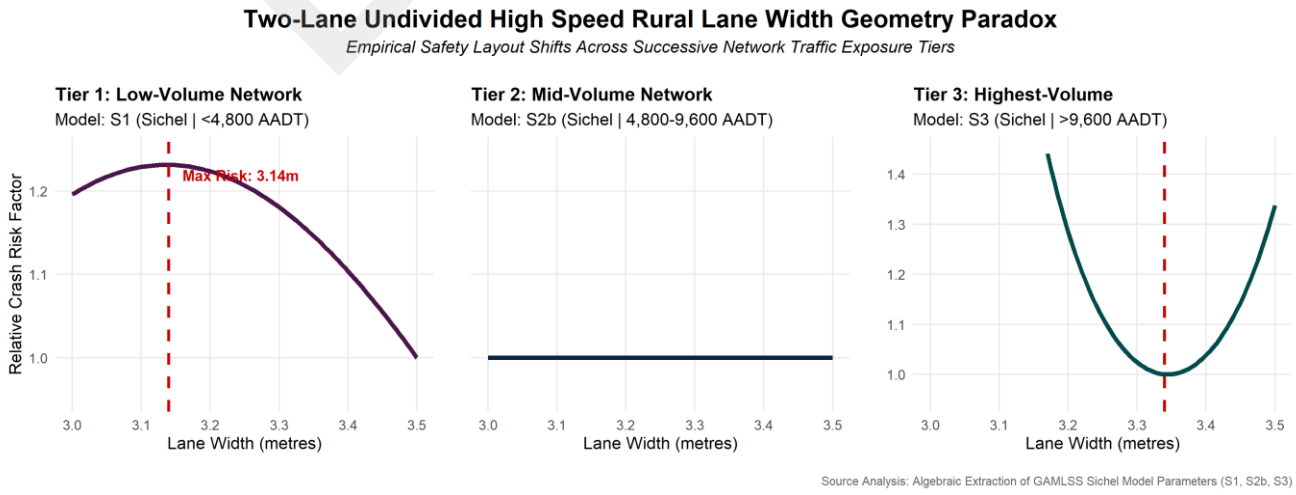

Figure 1. Two-Lane Undivided High Speed Rural Lane Width Geometry Paradox

Table 1. Estimated parameters for Poisson, Negative Binomial and Sichel models for low, medium and high volumes

	Poisson - Low Volume (P1)			Negative Binomial - Low Volume (N1)			Sichel - Low Volume (S1)			Poisson - Medium Volume (P2)			Negative Binomial - Medium Volume (N2b)			Sichel - High Volume (S2b)			Poisson - High Volume (P3)			Negative Binomial - High Volume (N3)			Sichel - High Volume (S3)		
	Coeff.	Std. Er.	P-Val	Coeff.	Std. Er.	P-Val	Coeff.	Std. Er.	P-Val	Coeff.	Std. Er.	P-Val	Coeff.	Std. Er.	P-Val	Coeff.	Std. Er.	P-Val	Coeff.	Std. Er.	P-Val	Coeff.	Std. Er.	P-Val	Coeff.	Std. Er.	P-Val
(Intercept)	-22.20	8.74	0.01	-22.75	10.21	0.03	-22.86	10.53	0.03	-7.07	16.51	0.67	-4.16	1.83	0.02	-3.99	1.85	0.03	58.51	46.80	0.21	55.52	93.05	0.55	129.32	94.59	0.18
LogAADT	0.92	0.02	<2e-16	0.92	0.03	<2e-16	0.93	0.03	<2e-16	0.55	0.17	0.00	0.56	0.21	0.01	0.54	0.21	0.01	0.67	0.35	0.05	0.69	0.65	0.29	0.68	0.66	0.31
LW	9.51	5.38	0.08	9.86	6.29	0.12	9.87	6.49	0.13	1.78	10.12	0.86							-37.85	27.83	0.17	-36.22	55.28	0.51	-80.44	56.27	0.16
LW^2	-1.52	0.82	0.07	-1.57	0.96	0.10	-1.57	0.99	0.11	-0.27	1.53	0.86							5.64	4.15	0.17	5.40	8.22	0.51	12.03	8.38	0.16
AIC	9904.7			9743.6			9721.0			1873.4			1819.9			1820.3			544.9			451.0			450.2		

Benefits to road safety

This study expands the research into nonlinear prediction models begun by Lee et al. (2015) and Pokorny et al. (2020) by looking at more refined lane width cross-section segmentation. The benefits of this will be that

- Road design costs may reduce, if narrower lanes are more appropriate in certain situations.
- Existing road cross sections can be optimised, with treatments such as WCLT or wider shoulders as the rise of multi-vehicle crashes (head on, rear end) outweigh the risks of single vehicle run off road risks.
- The reduction in the most common crash types, of run off road and head on crashes, in high speed, undivided two lane, straight rural environments, a key road type managed by road authorities.

Implications for policy and/or practice

The implications of this work are that road design standards should be reviewed to determine if higher volumes, past 9,800vpd, the standard traffic lane width of 3.5m may be considered to be reduced to 3.34m. Noting the reduced likelihood of large road trains on roads with these higher volumes, the narrowing will allow the reallocation of road space to facilitate either wider separation between vehicles, or wider shoulders.

Conclusions

The objective of this study is to examine the and understand the crash relationships related to lane widths, specifically in regards to non-intersection crashes on straight, undivided, two-lane high-speed roads. This objective has been achieved by the use of Negative Binomial Empirical Bayesian Nonlinear Regression analysis across 8,936km of road network to determining that lane width matches a non-linear polynomial curve, as found by previous research, although this study has highlighted the convex nature of this curve at higher volumes. Additional studies are required, undertake with comparison using Negative Binomial Lindley Empirical Bayesian Nonlinear Regression analysis, to determine:

- What relationship exists between the roads cross sectional elements
- What relationship exists on curved, undivided, two-lane high-speed roads
- What relationship exists on low speed roads
- What relationship exists for different crash types and crash severities
- If a modular crash prediction model can be developed incorporating the above research

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Smarter safety investment: deployment of the Safety Intervention Planning Tool

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Abstract
Improving the consistency, transparency, and effectiveness of road safety investment is essential to accelerating progress towards New Zealand's Road Safety goals. To support this, we developed a nationwide Safety Intervention Planning Tool (SIPT) - a geospatial, data driven platform that centralises the identification, assessment, and prioritisation of safety risks and opportunities across the road network. The tool provides a consistent, value for money assessment framework, incorporating key metrics such as fatal and serious injuries (FSI) saved per $100M, Safe System treatment alignment, and long-term safety level of service objectives. This abstract outlines the development process, the technical and geospatial innovations underpinning the tool, the initial deployment, and opportunities for other road controlling authorities. It also highlights future enhancements to support wider national consistency in road safety planning and accelerated delivery of targeted, high impact interventions.

Background
In 2024 the New Zealand Government released a new Government Policy Statement (GPS) on Land Transport. Whilst safety remained a Strategic Priority, the dedicated funding stream for safety improvements - the Road to Zero activity class was withdrawn both for local roads and state highways. With a renewed focus on efficiency, the expectation was that road safety should be improved through increased enforcement and targeted as a key outcome within the scope of major roading projects and through maintenance and renewals activities. In turn, this required NZ Transport Agency Waka Kotahi (NZTA) to update how they planned for and delivered on the commitment to safer roads, and particularly on safer infrastructure.

This change in funding approach led to the previous safety improvement planning tool, the Pipeline Development Tool (PDT), to be decommissioned at the end of 2024. PDT was originally built to support the Road to Zero strategy and subsequent programme development of the speed and infrastructure programme of works both for NZTA and Local Government. Despite this, users still required a simplified tool for understanding proposed road safety interventions and benefits and NZTA sought to maintain access to the previous data contained within PDT.

Conference theme
The SIPT helps to translate evidence both on road safety issues and effective interventions into a user-friendly platform that allows for identification and prioritisation of safety focused infrastructure improvements. In this way, it makes it easier and more effective to turn the available evidence into actionable programmes and projects. The tool allows for testing of different interventions, showing the likely effect of potential investments in a consistent and easy to use way that educates and enables users and can be easily used to communicate with leaders and decision makers.

Because the tool has a geospatial capability, this allows for easier cross-referencing of identified and prioritised infrastructure improvements with other projects (including maintenance and renewal) improving consistency of investment and expected outputs and outcomes across a network. This allows for more streamlined co-ordination of safety improvements with other activities, such as maintenance and renewals or major projects.

Method
The SIPT provides a spatial representation of every road corridor and intersection in the country. A wealth of road safety information sits under the map which allows the user to click on any corridor or intersection, identify the safety risk and explore the effect of different safety treatments. Under the previous policy settings and funding model, the PDT was used to identify a long list of safety projects which facilitated data led discussion and prioritization with Road Controlling Authorities. Under the current model the tool is now used more directly by those local authorities and NZTA regional offices to give objective safety information that can be ground truthed locally and assist in decision making. This allows small-scale safety improvements to be identified and programmed more efficiently, with improved transparency in treatment selection and expected outcomes.
To develop the SIPT, two key stages were required:

Stage 1 – Application Development
While the previously developed PDT tool informed the high-level functional intent of the SIPT, the new application was required to be developed from the ground up due to the deprecation of the legacy platform and the significant evolution of the underlying geospatial and application environment. This provided an opportunity to adopt contemporary, supported technologies and align the solution with current Agency standards.

A strong emphasis was placed on user-centred design, recognising that many users interact with the tool infrequently. The application was therefore designed to be intuitive and easy to use, with clear workflows, minimal configuration requirements, and sensible defaults to reduce training and support overheads.

As part of the data migration to the Agency, the application was developed within the ArcGIS Experience Builder environment. This approach enables immediate access to out-of-the-box functionality for security, authentication, role-based access, and responsive design, ensuring compliance with Agency security and design requirements without the need for extensive custom development. Importantly, this platform-based approach also supports ongoing maintainability and future updates, allowing the application to benefit from platform enhancements over time, reducing whole-of-life costs and the ongoing support burden on both the Agency and end users, and lowering long-term technical risk.

Stage 2 – Data Migration
Following the initial development of the Application, the existing PDT database was migrated into the Application. The data was reviewed to ensure that the data schema (how data is organised and stored) would be appropriate for how it may be used in the future i.e. how potential functionality can be catered for in the initial data setup. This allows some built-in flexibility in the tool that helps to accommodate future changes in both policy setting and variables (for example identifying how future output values, such as priority ratings, may be recalculated as variables change).

The outcome, is a tool that gives a centralised location for safety interventions (opportunities) to be captured and have a consistent value-for-money assessment framework, incorporating key metrics such as fatal and serious injuries (FSI) saved per $100M, Safe System treatment alignment, and long-term safety level-of-service objectives. The captured road safety opportunities primarily target safety retrofits that help improve the level of service (for safety) and align to what the future end state is for a particular part of the network. Interventions typically include the suite of primary and supporting safe system treatments such as: median barrier; wide centreline; roadside barrier; ATP/line marking improvements; restrictions on right turns; intersection speed zones; and traffic calming.

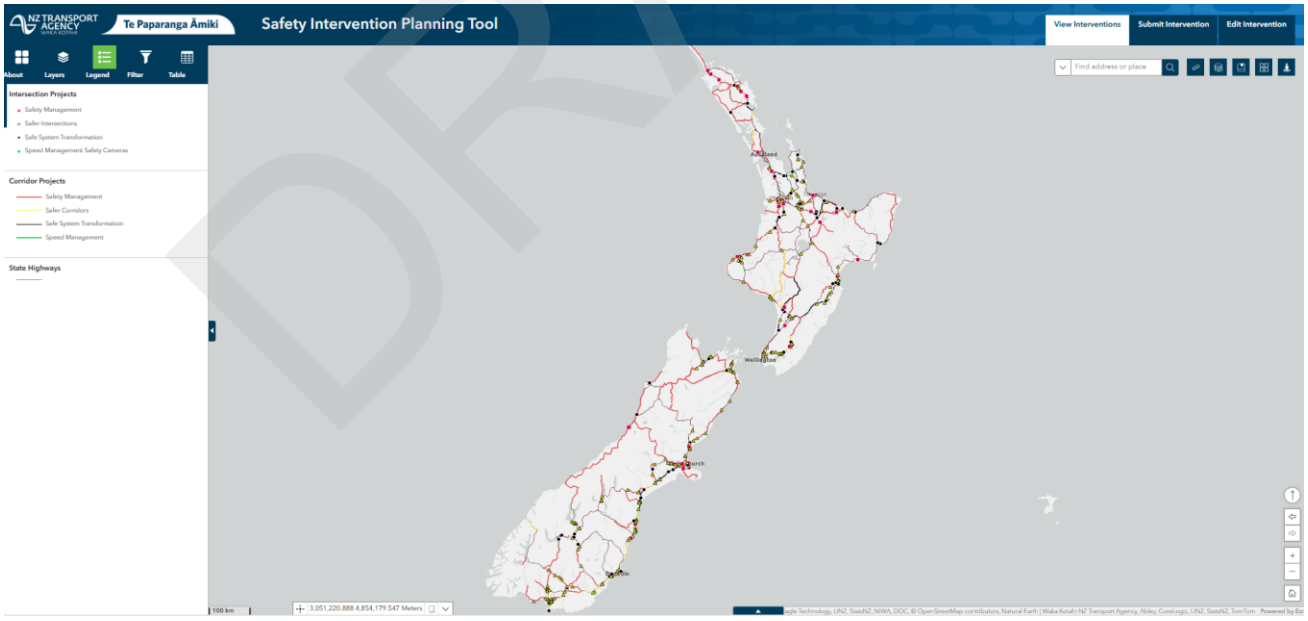

Figure 1. Display screen of the Safety Intervention Planning Tool showing the pipeline of opportunities that have been captured
Source: NZ Transport Agency

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More specifically, a user of this tool has the ability to:

- View and filter historic records e.g., search for all interventions by local council or State Highway (or similar attributes) and export to CSV file format;
- Edit and modify existing records without calculation changes;
- Create records using prepopulated data/inputs, e.g., if the intervention was a standard safety intervention, the cost/ benefit could be populated from a predetermined table; and
- Create records using dynamic backend calculations e.g., using X corridor length (captured from map interface) what is the cost and benefit of Y kms of median barrier.

Findings

The tool was piloted across both State Highways (National) and in the Whangārei district of New Zealand. The tool supported collaborative planning, revealing its capability to generate clearer, more robust investment pipelines and strengthen regional engagement. The trial demonstrated that small-scale safety improvements could be identified and programmed more efficiently, with improved transparency in treatment selection and expected outcomes. Its spatial design enables streamlined integration with modelling and/or programme level investment prioritisation.

> 'By being able to "test" different treatment types and lengths we will be able to develop a more comprehensive programme and better tell our investment story. Thank you for your teams help in getting this valuable resource included in our suite of data tools available in our Safety Dashboard.'
>
> Elizabeth Stacey
> Capital Works Project Manager,
> Transportation Department, Whangārei District Council

Benefits to road safety

The pipeline view of safety opportunities from the tool helps to evidence network need and gives the ability for decision makers to derive various scenarios on how to best respond to the safety risk of the network. By telling a consistent, evidence-based investment story the tool can be used to develop and promote road safety improvements across differing policy and funding settings.

Implications for policy and/or practice

Developing a tool that provides consistent, transparent information and evidence allows for the development of improvement programmes that are consistent nationally and tell a clear investment story across road controlling authorities. In turn this supports investment in safety improvements that can be targeted to current and future policy settings.

Conclusions

The development of the SIPT, and successes in its initial deployment demonstrate the importance of having tools and methods for making consistent, transparent and evidence-based safety investment decisions regardless of policy and funding settings. Having flexibility in the data schema can assist in managing tools in a way that is flexible to those changes.

Future Opportunities

The application is designed to be flexible and can be easily updated to reflect changing policy or variable settings. Additionally, future functionality could include:

- Overlaying the future safety level of service to help guide users on understanding if their submitted opportunity is aligned, a step towards or not aligned to what the network needs to look like to achieve a Vision Zero outcome (from an infrastructure perspective);
- Enable better integration with maintenance and operational interventions to inform investment programmes from both a safety and maintenance perspective e.g., incorporating curve treatment lengths to ensure a more holistic approach is taken to resealing programmes;
- Further integrating with crash data to monitor the effectiveness of outcomes that have been realised; and
- Enable predictive and forward looking capability to test and enable scenario planning
    - sensitivity testing of the tool e.g., what happens with increases in traffic growth or land use changes?
    - Bundling of staged treatment pathways (over delivery years or combinations of infrastructure, speed and movement changes) to dynamically assess outcomes over time
    - Include programme level optimisation e.g., budget optimisation, across regions

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Australian drivers' views on legalising recreational cannabis and drug driving

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Abstract
Cannabis is the most frequently detected drug in roadside tests of drivers in Australia. As several jurisdictions have legalised recreational cannabis and others are considering similar policies, understanding how legalisation may influence public perceptions regarding the safety of driving after cannabis use is a concern. This study surveyed licensed drivers from Queensland, New South Wales, and Victoria, collecting views on recreational cannabis legalisation and its potential impact on road crashes. Overall, 60.4% of drivers supported legalisation, while 18.2% were undecided, with higher support observed among cannabis users. Perceptions of safety impacts were mixed: 43.3% believed legalisation would not increase road crashes, 34.6% believed it would, and 22.1% were neutral. These findings suggest that misperceptions about safe driving after cannabis use are already common and may increase crash involvement. Public awareness and policy strategies should emphasise that driving after cannabis use remains illegal and unsafe, even when recreational use is legal.

Introduction
Driving after substance use is receiving increasing attention in the field of road safety. While driving after consuming alcohol has historically received the greatest attention, drug driving has emerged as an increasingly concerning issue (Hasan et al., 2022). Cannabis is one of the most commonly used psychoactive substances globally (Wang et al., 2024) and is frequently detected among drivers involved in crashes (Di Rago et al., 2025). Experimental and epidemiological research indicates that cannabis use can impair cognitive and psychomotor functions essential for safe driving, including attention, reaction time, lane tracking and decision-making (McCartney et al., 2021). Meta-analyses have shown that driving under the influence of relatively high blood THC (the psychoactive ingredient of cannabis) concentration is associated with an increase in crash risk, typically described as low to moderate in magnitude (Albrecht et al., 2025).

In Australia, the roadside drug testing (RDT) program has been widely implemented to detect drivers positive to a range of illicit substances, including cannabis. This program operates under a zero-tolerance framework, whereby drivers can be penalised if certain drugs are detected, regardless of whether impairment is demonstrated. Cannabis continues to be the most frequently detected drug in RDT testing across several Australian jurisdictions (Mills et al., 2021; Teperski et al., 2024). The issue has gained increasing policy attention as several jurisdictions around the world have legalised recreational cannabis use, including the Australian Capital Territory (ACT), Canada and several states in the United States. Additionally, cannabis has been legalised for medical purposes in Australia since 2016, but this is not the focus of this research. Legalising recreational use of cannabis has raised concerns about potential increases in its consumption (Wang et al., 2024) and the possibility of greater prevalence of driving after using cannabis (Brubacher et al., 2022). Although research examining the impact of cannabis legalisation on road safety outcomes has produced mixed findings (Brubacher et al., 2022; Arkell, 2025), some studies suggest that cannabis-positive drivers may become more common following legalisation (Brubacher et al., 2022).

As debates about cannabis policy continue, understanding how drivers perceive cannabis use and its potential impact on road safety is becoming increasingly important. Public perceptions and attitudes toward cannabis and driving can influence drivers' behaviour and compliance with road safety laws. If drivers believe that cannabis use does not significantly increase crash risk, they may be more likely to engage in drug driving. This research aims to examine drivers' opinions on the legalisation of recreational cannabis use, explore their perceptions of how such legalisation may influence road crashes and provide valuable insights for policymakers and road safety practitioners.

Conference theme
There is a need to translate evidence on drivers' attitudes towards recreational cannabis legalisation into effective road safety awareness messages that discourage driving immediately following cannabis use to protect all road users.

Method

Participants

A total of 1,483 participants (M_{age} = 37.8 years, SD = 16.6; Range 18-84 years) from Queensland (59%), New South Wales (24%), and Victoria (17%) completed an online survey after meeting eligibility criteria: being 18 years of age or older, holding a valid driver's licence, residing in one of the three states, and having used illicit drugs and/or alcohol within the past 12 months. Data were collected between May and October 2021. Participants were recruited through the <de-identified> university mailing lists, a first-year Psychology participant pool, and Facebook advertising. Of these participants, 41.1% were female, 57.9% male, and 1.0% identified as other. Most participants reported living in urban areas (72%), while 20% lived in regional areas, 7% in rural areas, and 1.0% in remote areas. The average weekly driving time was 13 hours (SD = 26.8).

Measures

The current research measured sociodemographic characteristics and past involvement in crashes. The Alcohol, Smoking and Substance Involvement Screening Test (ASSIST, version 3.1) was used to assess the problematic substance use (Humeniuk et al., 2010). Self-reported driving after drug use (including cannabis) and perceptions on cannabis legalisation were also measured. Respondents were asked, "*Over the past 3 months, have you driven your vehicle within one hour of taking this drug?*" with responses measured on a 5-point Likert scale ('never' to 'always'). The survey sought participants' views on cannabis regulation by asking them if they "*thought cannabis should be legalised for recreational purposes*". The response categories were 'yes', 'no', and 'undecided'. The next question asked participants about their perspectives on "*how likely the legalisation of cannabis would lead to an increase in road crashes",* with responses measured on a 5-point Likert scale ('extremely unlikely' to 'extremely likely'). Data was analysed using Bivariate Chi-Square tests.

Results

Of the total sample, 613 (41.3%) were drug users, who used one or more of the drugs surveyed in the past three months, and 478 (32.2%) of them used cannabis. Overall, 286 (19.3%) participants reported drug driving in the past three months, of which 205 (13.8%) indicated driving after consuming cannabis.

Most drivers supported the legalisation of recreational cannabis, with six in ten drivers (60.4%) stating that cannabis use should be legal for recreational purposes, while 18.2% were undecided. Participants who reported drug driving were significantly more supportive of legalisation than non-drug drivers (χ^2 (2, N= 1483) =128.46, p <.001). Support for legalisation was independently associated with being male, employed, receiving a high or middle income, and being drug dependent. Views on the potential impact on road safety were mixed: 43.3% believing legalisation would not increase road crashes, 34.6% believing it would, and 22.1% being neutral. The perception that crashes would not increase was more common among adults (aged 25 and over), males, employed participants, those with middle or high incomes, and those reporting drug dependence. Concerningly, among the 379 participants who reported involvement in at least one crash in the past (e.g., related to drug use, speeding, distraction, etc.), 11% (n = 158) believed crashes were unlikely to increase following legalisation; among these, nine had previously been involved in one or more drug driving-related crashes.

Among cannabis users, the vast majority (90%) supported legalisation of recreational cannabis, particularly those reporting problematic cannabis use (χ^2 (2, N= 478) =18.15, p <.001). Participants who reported driving after using cannabis were also more supportive of legalisation than non-cannabis drivers (χ^2 (2, N= 478) =8.08, p <.05). Notably, 71% of cannabis users believed that legalising cannabis for recreational purposes was unlikely to increase road crashes. This perception was associated with being aged 25 years or older, male, employed, receiving a high or moderate income, and being cannabis dependent. Furthermore, 18.6% (n = 89) of cannabis users who reported being involved in at least one crash in the past indicated that crashes were unlikely to increase after legalisation, and 7 of them had been involved in at least one or more drug driving-related crashes in the past.

Benefits to road safety

As some jurisdictions consider legalising recreational cannabis, this research provides insights that can guide interventions aimed at reducing drug-impaired driving and improving road safety outcomes. The findings highlight that many drivers believe that legalisation would not increase crash involvement, including a large proportion of cannabis users, indicating misconceptions about the risks of driving after cannabis use. Understanding these misperceptions helps inform the development of targeted education and public awareness campaigns and provides baseline data on driver opinions and behaviours that can be used to monitor changes over time.

Implications for policy and/or practice

The findings of this study have several implications for road safety policy and practice in the context of potential recreational cannabis legalisation in Australia. First, the strong public support for legalisation in this sample (60.4%) suggests that community attitudes toward cannabis are permissive. Concurrently, a large proportion of drivers (43.3%) believe that legalising recreational cannabis would not increase road crashes, and this perception was especially common among cannabis users (71%). These findings indicate that many drivers, including those engaging in drug driving, may underestimate the road safety risks associated with cannabis use. From a policy perspective, this highlights

the need for governments and road safety agencies to proactively address misconceptions about driving after cannabis use. If additional jurisdictions legalise recreational cannabis, there is a risk that some drivers may interpret legalisation as implying that cannabis use is safe in all contexts, including driving. To counter this, targeted public education campaigns should clearly communicate that driving after using cannabis remains illegal and increases crash risk. Furthermore, enforcement strategies should continue to prioritise drug driving detection and deterrence. As the most commonly detected drug in roadside oral fluid testing in Australia, increased social acceptance could potentially lead to a higher prevalence of drug driving. Maintaining roadside drug testing programs would reinforce the message that drug driving remains a serious road safety offence regardless of the legal status of cannabis. Overall, the findings suggest that if recreational cannabis legalisation were adopted by new jurisdictions in Australia, it should be accompanied by coordinated road safety strategies, including public education and continued enforcement of drug driving laws.

Conclusions

The study showed that most drivers support the legalisation of recreational cannabis, although opinions remain divided regarding its potential impact on road crashes. A substantial proportion of drivers, particularly cannabis users, believe that legalisation would not affect road safety, suggesting a possible underestimation of the risks associated with driving after using cannabis. Drug driving was also commonly reported, with many individuals who engage in this behaviour expressing strong support for legalisation. These perceptions raise concerns that legalisation may unintentionally normalise recreational cannabis use, which might be linked to an increased likelihood of post-consumption driving. If cannabis were legalised, clear public messaging would be necessary to emphasise that driving after cannabis use remains illegal. Road safety education and enforcement would be crucial to deterring this behaviour and to help minimise potential increases in drug-related crashes.

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Misjudging e-scooter and e-bike speeds may contribute to intersection crashes

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Abstract
To turn safely at an unsignalised intersection, a driver must be able to predict when other vehicles will cross their intended path. This study examines how well drivers can predict the future positions of e-bikes and e-scooters, whose speeds may differ from traditional bicycles or larger vehicles. Thirty-five drivers viewed footage of seven types of vehicles (bicycle, e-bike, e-scooter, motorbike, small car, SUV, truck) approaching an intersection at a range of realistic speeds. E-scooters and e-bikes (but not conventional bicycles) were judged to arrive later than larger vehicles, particularly when travelling quicker. This suggests that their atypical size-to-speed ratio and limited perceptual familiarity lead motorists to overestimate the time available to execute turning manoeuvres—an error that may increase collision risk. This reinforces the need to better regulate the speeds of e-scooters and e-bikes.

Introduction
E-scooters and e-bikes have rapidly proliferated on urban roads in Australia and worldwide. While most e-scooter and e-bike injuries do not involve motor vehicles, this is not true for the most serious incidents (ITF, 2024). In Queensland, for example, 359 of the 495 police-reported crashes of Personal Mobility Devices (mostly e-scooters) between 1 November 2022 and 31 March 2024 were multi-vehicle crashes, of which about 85% were angle crashes. These crashes are likely to have occurred at intersections. In the US, 47% of shared e-scooter fatalities occurred at or near intersections, compared to 38% of bicycle fatalities and 36% of moped/motorised bicycle (the category that includes e-bikes) fatalities (Karpinski et al., 2023). In Australian crash data, e-bikes and conventional bicycles cannot be distinguished.

To turn safely at an uncontrolled intersection, a driver must be able to predict when other vehicles will cross their intended path. Earlier research established that drivers often misjudge the approach speed of smaller vehicles, particularly motorcycles (e.g., Horswill et al., 2005), increasing the risk of a collision at an intersection. E-scooters and e-bikes combine the small visual profiles of bicycles or pedestrians with motorised acceleration and higher travel speed capabilities, introducing perceptual challenges for other road users. In a test track study, Petzoldt et al. (2017) found drivers indicated shorter acceptable gaps for crossing in front of an e-bike compared to an almost identical conventional bicycle travelling at the same speed. They speculated that drivers based their judgement of speed on the apparent effort of the rider, which was lower for the e-bike. In a related study, Schleinitz et al. (2020) showed participants videos of approaching bicycles, e-bikes and scooter-style motorcycles. Participants accepted smaller gaps and made longer estimates of how long the vehicles would take to arrive at the intersection for the two types of bicycles than the scooter-style motorcycle. Given the similar physical size of these vehicles, the results suggests that drivers also consider the mass of the oncoming vehicle in their assessments, as this can signify its level of potential threat.

The current study examines how well drivers can predict the future positions of e-bikes and e-scooters, compared to traditional bicycles or larger vehicles and how this is influenced by the speed of these vehicles.

Conference theme
This paper gathers evidence regarding the extent to which basic perceptual processes may contribute to crashes between motor vehicles and e-scooters and e-bikes at intersections which could guide the development of prevention programs.

Method
The video-based experiment assessed the influence of vehicle type (bicycle, e-bike, e-scooter, motorbike, small car, SUV, truck), speed, and prediction window (1, 2 or 3 sec) on driver estimates of time-to-arrival (TTA) at an intersection. The e-bike was a legally compliant pedelec (Kalkhoff 3B Endeavour) and the e-scooters were privately-owned. Vehicle speed increased in 5 km/h increments from 5 to 30 km/h for the bicycle, 5 to 35 km/h for the e-scooter and e-bike, and 10 to 60 km/h for the motorbike, small car, SUV, and truck. Each of the 35 participants (holders of Australian or international driver's licences with normal or corrected-to-normal vision) was presented with all possible combinations three times, resulting in 576 trials per participant.

The video clips were recorded at two locations on a closed driving circuit. They depicted single vehicles travelling downhill towards a T-intersection from the perspective of a car driver seated behind the wheel waiting to turn right across the path of the oncoming vehicle. The 'arrival point' was represented by a digitally superimposed yellow line overlaid on the road surface. Each clip was presented for 3 seconds until 1, 2 or 3 sec remained (the prediction window) before the oncoming vehicle would reach the arrival point. Participants were instructed to press the space bar when they thought the front of the oncoming vehicle would reach the arrival point. The duration from the start of the response window to the participant's response was recorded as the estimated TTA. The sequence of events is depicted in Figure 1.

As in previous research, the dependent variable was the TTA estimation error ratio: $Rdiff = \frac{Estimated\ TTA}{Actual\ TTA}$. Values > 1 indicate overestimation of TTA and < 1 indicate underestimation of TTA. Linear mixed-effects models (LMMs) were fitted with the lme4 package (Bates et al., 2015) to examine predictors of TTA estimation error ratio, including vehicle type, speed, and time-remaining.

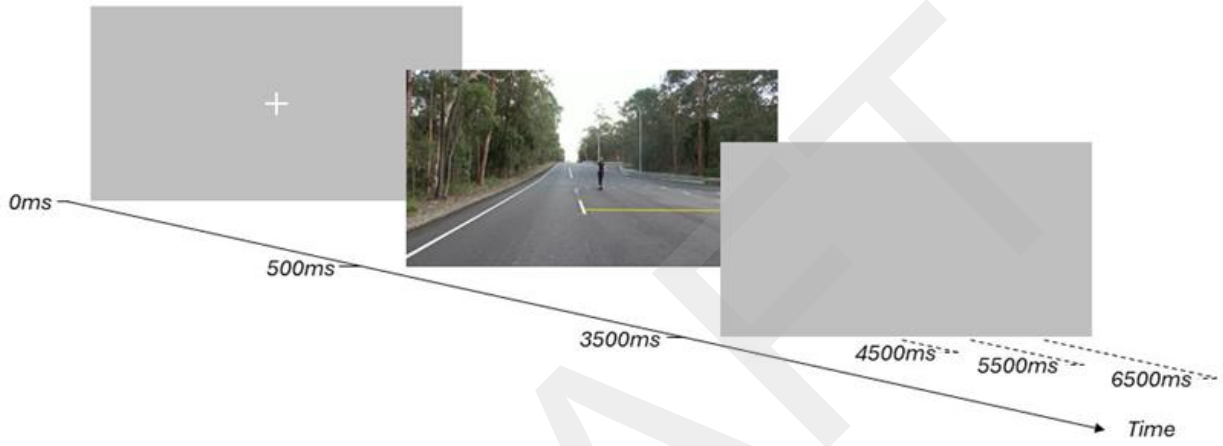

Figure 1. Schematic representation of a single experimental trial

Results

Across all three prediction windows, the TTAs for motorbikes were consistently overestimated relative to larger vehicles (all ps < .05), consistent with previous literature (Horswill et al., 2005), suggesting a stable bias unaffected by time remaining. In contrast, the pattern for e-bikes and e-scooters varied with the length of the prediction window. E-scooter TTAs were significantly overestimated relative to cars, SUVs, and trucks in the 1-second condition (M = 1.96 vs. 1.77–1.85; all ps < .05), but not in the 2- or 3-second conditions (all ps > .05). E-bikes showed a similar but less pronounced pattern: overestimation exceeded that of cars in the 1-second condition (p = .01), though not that of SUVs or trucks. However, in the longest (3-second) condition, e-bikes were again overestimated relative to all large vehicles (M = 1.45 vs. 1.33–1.37; all ps < .05).

Participants made larger prediction errors when the vehicle was moving faster, $F(1, 17784) = 234.95$, $p < 0.01$. This effect was greatest for e-bikes and e-scooters (Figure 2). Specifically, a one-unit increase in speed was associated with a 91.03% increase in the overestimation of TTA for e-bikes and a 65.20% increase for e-scooters, compared with 6.41% for bicycles and 33.11% for motorbikes.

The TTAs for e-scooters were significantly more overestimated than larger vehicles once speed exceeded approximately 5 km/h (Rdiff = 1.34), with overestimation increasing with speed and approaching a twofold bias when extrapolated to 60 km/h (Rdiff = 2.43). For e-bikes, significant overestimation relative to larger vehicles emerged only at higher speeds: around 26 km/h in the 1-second condition (Rdiff = 1.67) and 27 km/h in the 2-second condition (Rdiff = 1.46). These thresholds correspond to spatial overestimations of approximately 4.8 m and 3.5 m, respectively, indicating substantial losses in perceived safety margin as speed increases. The speed-dependent overestimation of e-bikes and e-scooters emerged primarily under tight temporal constraints.

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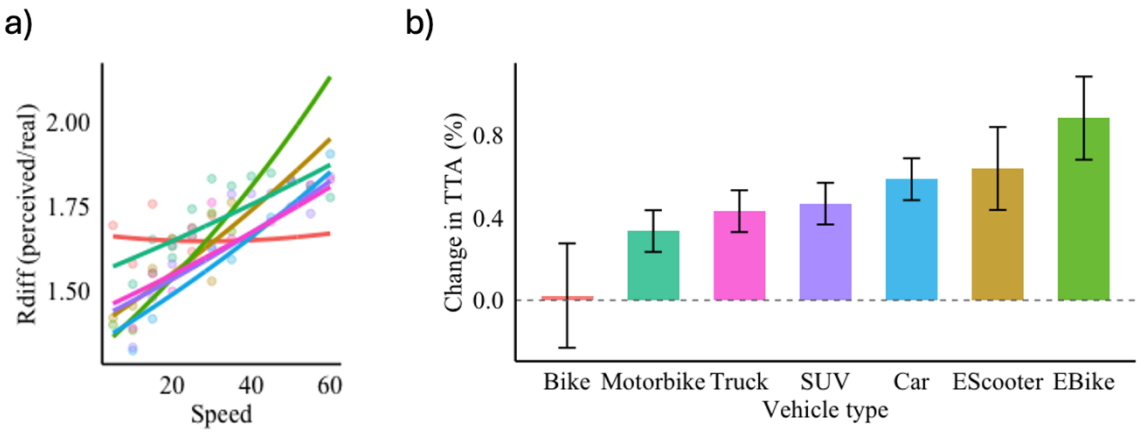

Figure 2. Perceived time-to-arrival and response accuracy (ratio difference) for vehicle effects

Benefits to road safety

This research provides new empirical evidence on how motorists perceive the motion of emerging micromobility vehicles. Across conditions, drivers systematically overestimated the arrival time of smaller and faster vehicles, revealing that e-bike and e-scooter collisions may partly stem from fundamental perceptual limitations. These results confirm that basic perceptual processes can contribute to driver error at intersections and can be used to devise programs and strategies to overcome the limitations of human performance.

Implications for policy and/or practice

The results imply that, as well as being at higher risk of severe injury, e-scooter and e-bike riders travelling at high speeds may be at higher risk of crash involvement because drivers may misperceive their future position and so turn in front of them. This reinforces the need to better regulate the speeds of e-scooters and e-bikes.

Conclusions

Overall, e-scooters and e-bikes were judged to arrive later than larger vehicles travelling at the same speed. The size of the error increased with the speed of the vehicle and the relative size of the error was greater when the vehicle was not visible until nearer the intersection, particularly for e-scooters. Together, these findings provide the first comprehensive behavioural evidence of how e-bikes and e-scooters are perceived within realistic traffic contexts, extending theoretical accounts of motion prediction and visual timing to novel vehicles.

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DRAFT

Teaching road safety in language across remote and regional Australia

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Abstract (limit: 150 words)

First Nations peoples are nearly three times more likely to die in road crashes than non-Indigenous Australians (DITRDCA, 2023), yet culturally appropriate road safety education remains critically absent from remote communities. The Indigenous Road Safety Academy (IRSA) DriveAbout program is a blended suite of learning resources developed for First Nations peoples, delivered in language and designed to bridge this gap by reducing road-related injuries and deaths, reducing incarceration and recidivism linked to unlicensed driving, and ultimately creating pathways to employment, independence, and broader vehicle literacy. In 2025, IRSA led enablement sessions within seven partner organisations across the Northern Territory and Queensland to independently deliver the IRSA DriveAbout program across their schools and community programs to help increase licensing outcomes. This paper presents the program model and outcomes, demonstrating that community-owned, language-first education offers a tested and scalable pathway to closing the gap in First Nations road safety outcomes.

Background

First Nations peoples are disproportionately represented in Australian road trauma, bearing a significantly higher burden than non-Indigenous Australians across rates of fatality, serious injury, and hospitalisation, often with long-term consequences (Pammer et al., 2021; DITRDCA, 2023). In the Northern Territory, where IRSA operates most extensively, this overrepresentation is particularly acute: First Nations people represent approximately 30% of the population yet account for around 50% of road deaths and 30% of serious injuries (DITRDCA, 2023).

Unlicensed driving is a critical and compounding factor in this crisis. A 2013 audit found that 43% of Aboriginal and Torres Strait Islander licence holders held only a Learner's or Provisional licence, indicating widespread barriers to progressing through the licensing system (DITRDCA, 2023). Driver's licence offences represent the highest offence category for convictions of Indigenous peoples, with more than 90% of people incarcerated for driving offences across Australia being Indigenous (Pammer et al., 2021). Importantly, these are not barriers of attitude or motivation. Studies confirm that First Nations people hold comparable road safety attitudes to non-Indigenous Australians (Pammer et al., 2021). What prevents equitable access is systemic: geographic isolation, literacy challenges, the absence of resources in language, prohibitive costs, and identity document requirements (Pammer et al., 2021; DITRDCA, 2023). Programs that meaningfully engage communities in their development and delivery have been shown to be the most effective in addressing these barriers (DITRDCA, 2021).

Conference theme

IRSA directly transforms evidence of systemic inequity into action by embedding road safety into the organisations communities already trust — schools, health boards, ranger programs, and police — through sustained, multi-sector collaboration under First Nations leadership. Australia is at serious risk of missing its 2030 road safety targets without urgent, targeted action for First Nations communities (DITRDCA, 2021), and IRSA's model speaks directly to this need. By demonstrating how trusted, culturally grounded messengers create lasting road safety commitment, and by expanding across health, justice, education, and land management sectors, the program exemplifies the cross-sector collaboration the National Road Safety Strategy 2021–2030 identifies as critical to achieving its targets (DITRDCA, 2021).

Project description

The IRSA DriveAbout program employs a blended learning model combining digital and physical tools to maximise reach and cultural relevance across diverse remote and regional contexts. The suite is designed to meet learners where they are, including those with lower levels of literacy and limited prior experience with formal education. This ensures that the taught road safety knowledge is accessible, engaging, and delivered in a way that reflects how Aboriginal and Torres Strait Islander peoples learn and speak. The suite comprises of:

- IRSA App: Road rules and road safety animated content available in Anindilyakwa, Pitjantjatjara, Arrernte, Torres Strait Creole, Kimberley Kriol, Warlpiri, Murrinh-Patha, Yolngu Matha, with content available offline via USB for communities without reliable internet access.
- Learning Management System (LMS): Providing a structured learning platform with quizzes for more independent learners. With the ability to track learner progress and generate measurable outputs for partner organisations and funding bodies.

- Mentoring Mats and Model Cars: Large-format, visual road mats for hands-on, scenario-based learning structured around the evidence-based 'I do, we do, you do' peer learning methodology.
- Trainer's Guide: Supporting independent local delivery capacity and guiding the use of all materials.

Between March and October 2025, the founder of IRSA delivered a series of structured enablement sessions equipping partner organisations with the skills and resources to embed road safety education into their existing programs. Three partner organisations, Nyangatjatjara College (NC), Katherine West Health Board (KWHB), and Mithangkaya Nguli Young People Ahead (MNYPA), are recipients of the National Road Safety Action Grants Program, independently validating the evidence-based rationale for IRSA's approach.

Table 1. IRSA partner organisations, 2025. * National Road Safety Action Grant recipient

Organisation	Location	Sector / Key Partners
Katherine West Health Board (KWHB)*	Remote NT	Community health
Northern Land Council (NLC)	Darwin / Top End NT	Rangers + NT Police + Kullaru Training & Assessing
Yirrkala School + DEMEX	East Arnhem Land	Education / Industry: Yolŋu Matha delivery
Laynhapuy Homelands School	East Arnhem Land	Remote homeland education (Dept of Education NT)
Nyangatjatjara College (NC)*	Central Australia	Education: Partner since 2020
Mithangkaya Nguli Young People Ahead (MNYPA)*	Mount Isa, QLD	Youth services

Results

Licensing Outcomes

The most significant quantitative outcomes to date were achieved at Nyangatjatjara College, which has partnered with IRSA since 2020. As NC did not run a structured driver licensing program prior to the IRSA partnership, no comparable baseline exists; these figures represent the first systematically recorded licensing outcomes at these campuses. Outcomes were reported by NC's driver trainer staff following sustained engagement with the IRSA DriveAbout program at the Mutitjulu and Imanpa campuses in 2025. Within a single 12-month period, 36 participants achieved licensing milestones in some of the most geographically isolated communities in Australia. While attribution to IRSA alone cannot be claimed, NC's broader community support infrastructure also contributes, the program was the primary vehicle for licensing preparation across both campuses:

- 26 Learner's Licences obtained (20 from Mutitjulu, 6 from Imanpa)
- 10 Provisional Licences obtained (8 from Mutitjulu, 2 from Imanpa)

Qualitative Evidence

Across all 2025 enablement sessions, participants consistently identified the program's cultural and linguistic relevance as its defining strength, filling a gap the sector has long acknowledged but failed to address (DITRDCA, 2023; Pammer et al., 2021). Educators described language-first delivery as transformative, with one teacher noting that hearing road rules explained in Yolŋu Matha "really stuck" with students (Z. O'Connor, personal communication, April 2025), while the principal of Nyangatjatjara College questioned why government was not already providing "service delivery in language" to Aboriginal students (P. Unsworth, personal communication, May 2025). Health partners described the suite as "a proper travelling toolkit" suited to remote and on-Country delivery (M. Gotsalks, personal communication, March 2025). NT Police identified benefits beyond road safety, noting the program's potential to reduce incarceration and recidivism by supporting young people into licensing before adverse justice contact occurs (Detective Senior Constable, personal communication, May 2025). Industry partners emphasised that having "First Nations people teaching First Nations people" was essential for building lasting community trust (M. Collins, personal communication, April 2025).

Benefits to road safety

The IRSA DriveAbout program delivers road safety benefits that are both direct and systemic:

- Individual outcomes: Unlicensed community members gain the knowledge and confidence to progress through the licensing system. Licensing is not merely a road safety outcome; for remote First Nations communities it is a gateway to employment, healthcare access, and fulfilment of cultural responsibilities (Pammer et al., 2021).
- Community sustainability: By equipping trusted local organisations, including schools, health boards, and ranger groups, to deliver the IRSA DriveAbout program independently, IRSA builds ongoing road safety capacity that does not depend on externally-driven programs or fly-in fly-out providers. The 'I do, we do, you do' methodology is specifically designed to embed this capacity at the community level.
- Cross-sector reach: By engaging NT Police, health workers, ranger program staff, and educators simultaneously, IRSA creates a shared, community-wide practice around road safety, extending the program's reach and reinforcing its messages across multiple trusted relationships.
- Justice outcomes: NT Police participants identified the IRSA DriveAbout program's potential to reduce incarceration by supporting young people into licensing and employment before adverse justice contact occurs,

consistent with national evidence that driver's licence offences represent the highest offence category for convictions of Indigenous peoples, with more than 90% of people incarcerated for driving offences across Australia being Indigenous (Pammer et al., 2021).

Implications for policy and/or practice

IRSA's outcomes have direct implications for road safety policy design and investment.

- Language-first design: The common finding across IRSA's 2025 sessions, that delivering content in community language transformed engagement, reinforces national evidence that culturally appropriate program design is not optional but essential for First Nations road safety outcomes (DITRDCA, 2023; Pammer et al., 2021).
- Making youth a priority: Young First Nations people aged 15–17 represent a critical intervention point, yet a significant gap remains in school-based delivery. Greater coordination between road safety organisations, education departments, and school communities is needed to systematically embed programs like the IRSA DriveAbout into school settings at the point where road safety education will have the greatest preventative impact.
- Community-led delivery over top-down programs: Evidence confirms that road safety education is most effective when communities are involved in development and delivery (DITRDCA, 2021). IRSA's model, First Nations-designed, delivered, and embedded in existing community organisations, operationalises this principle at scale.
- Culturally responsive pedagogy must drive program design: Delivering road safety education effectively across remote and regional communities requires more than physical access, it requires content that meets learners where they are. IRSA's blended learning suite demonstrates that road safety programs can be designed to reach learners across diverse literacy levels, language backgrounds, and geographic contexts.
- Scaling requires sustained investment: Replication of the IRSA model involves real constraints that funders and policymakers should account for. Partner organisations are often under-resourced and short-staffed, making uptake dependent on grant funding rather than core budgets. Finding local facilitators is challenging, and cultural obligations such as periods of sorry business can interrupt program continuity. These are structural constraints, not program failures, and they point to the need for long-term investment rather than one-off funding cycles.

Conclusions

Aboriginal and Torres Strait Islander peoples die on Australian roads at nearly three times the rate of other Australians, unlicensed driving is both a safety and justice crisis, and existing education has not met the need (DITRDCA, 2023; Pammer). Achieving Australia's 2030 road safety targets requires effective, targeted action for First Nations communities (DITRDCA, 2021). The IRSA DriveAbout program demonstrates that this action is possible. With 36 licensing milestones at Nyangatjatjara College in a single year, enablement sessions delivered across seven partner organisations in two states and territories, and three National Road Safety Action Grant partnerships, IRSA offers the sector a tested, replicable, and community-owned model for closing one of the most persistent and deadly gaps in the national road safety system.

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DRAFT

Development of a VR eye-tracking platform for UK overseas drivers

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Abstract
Overseas drivers adapting to the United Kingdom's traffic system frequently encounter unfamiliar driving challenges, which can affect road safety. This paper presents the development and application of an immersive virtual reality (VR) and eye-tracking experimental platform designed to investigate the behavioural and attentional mechanisms underlying these difficulties. Fifteen overseas drivers with no prior UK driving experience completed scenario-based driving tasks within a controlled VR environment integrating violation logging and gaze analytics. Results showed that the roundabout scenarios produced the lowest success rate, while failure to use appropriate turning signals and misunderstanding arrow traffic lights were the most frequent behavioural violations. Scenario-level analysis revealed consistent confusion patterns, and eye-tracking metrics provided deeper insight into whether errors were primarily driven by knowledge gaps or attentional misallocation. The study demonstrates how combining VR and eye-tracking enables fine-grained investigation of cross-cultural driver adaptation, informing evidence-based interventions for improving road safety.

Introduction
Traffic crashes remain a major global public health challenge, causing approximately 1.2 million fatalities and more than 50 million injuries annually (World Health Organization, 2024). Nearly 70% of road crashes are attributed to driver error, with many serious collisions arising from perceptual and recognition failures rather than intentional violations (Suto *et al.*, 2020). While foreign drivers have been reported to experience higher crash rates and injury severity (Yoh et al., 2017; Alogaili & Mannering, 2020), current licence-exchange and reciprocity arrangements are typically negotiated on an administrative or political basis, with little evidence that they are informed by systematic road safety performance comparisons across countries (American Association of Motor Vehicle Administrators, 2016). Together, these factors highlight the need to systematically identify and understand the specific challenges faced by overseas drivers in order to develop targeted, evidence-based safety interventions. Using the United Kingdom as a case study, this research presents the development and application of an immersive VR and eye-tracking experimental platform designed to investigate behavioural violations and attentional mechanisms among overseas drivers. By analysing scenario-level performance and gaze behaviour in complex situations, such as roundabouts and traffic-signal interactions, the study aims to provide deeper insight into cross-cultural driver adaptation and support evidence-based road safety interventions.

Conference theme - From Evidence to Action: Shaping a Brighter Future
This study shows how behavioural and eye-tracking evidence can be translated into actionable road safety insights for overseas drivers adapting to unfamiliar traffic systems. Using an immersive VR and eye-tracking platform, the research moves beyond identifying violations to explaining why they occur by distinguishing knowledge gaps from attentional failures in complex UK left-hand traffic (LHT) scenarios such as roundabouts and traffic-signal interactions. The findings support targeted training, risk communication, and future interventions to reduce cross-cultural driving errors.

Method
An immersive VR experimental platform was developed to investigate behavioural violations and visual attention among overseas drivers adapting to the UK traffic system (Figure 1). The platform combined an HTC Vive Pro headset with integrated eye-tracking and a Logitech G29 steering wheel and pedal set to enable realistic driving interaction while recording behavioural and gaze data. The virtual environment was developed in Unity 2021.3 LTS to replicate UK-specific road layouts based on previous phenomenological research, including arrow-signal junctions, various roundabouts, traffic calming systems, zebra crossings, cyclists, and special lanes. Fifteen overseas drivers (8 males, 7 females; 12 from right-hand traffic countries) holding non-UK licenses and lacking prior UK driving experience were recruited in Bristol, UK, via promotional posters displayed around the Bristol Robotics Laboratory, to complete scenario-based tasks. During driving, behavioural performance (e.g., signalling, lane positioning, and traffic-light responses) and eye-tracking data were recorded, followed by short post-drive interviews to help explain observed failures.

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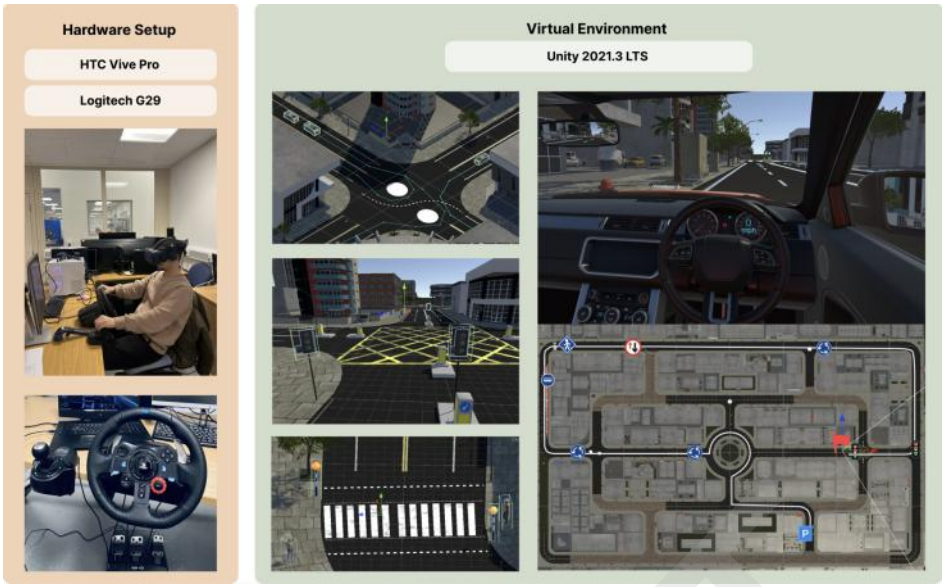

Figure 1. Overview of the VR Eye-Tracking Experimental Platform and Virtual Driving Environment Source: Author's own work

Results

Scenario Performance and Behavioural Violations

Performance varied across scenarios, revealing different challenge levels. Scenario success was defined as completing the task without a collision and obeying all traffic rules, including using correct lanes, signaling properly, giving way to pedestrians, and maintaining safe distances from cyclists. The highest success rates were observed for zebra crossing (86.67%), special lane (86.67%), and passing cyclists (80%). In contrast, roundabout-related scenarios generated the lowest performance, with the double roundabout producing the lowest success rate overall (6.67%), followed by X-junction (13.33%), appropriate turning signal (13.33%) and responding to ambulances (20%). Although some participants avoided collisions, in safety science, near-miss events are considered critical indicators because they reveal underlying risk mechanisms before severe outcomes occur and therefore provide valuable opportunities for prevention (Bugalia *et al.*, 2021). This highlights the importance of analysing behavioural performance beyond binary pass–fail outcomes. Analysis of system-logged driving behaviour showed consistent violation patterns across participants. The most common behavioural issue was failure to use appropriate turning signals, which occurred across multiple scenarios, particularly in roundabout navigation. Additional recurrent errors included misinterpretation of arrow traffic lights, incorrect lane selection, turning into opposite lanes, and failure to give way to other road users or react to ambulances. Post-experiment interviews suggested some behaviours were influenced by prior driving habits, such as assuming right-hand traffic priorities. Others were linked to knowledge gaps, including misunderstanding arrow traffic-light conventions, cyclist clearance rules, pedestrian priority, and emergency vehicle yielding.

Eye-Tracking Observations

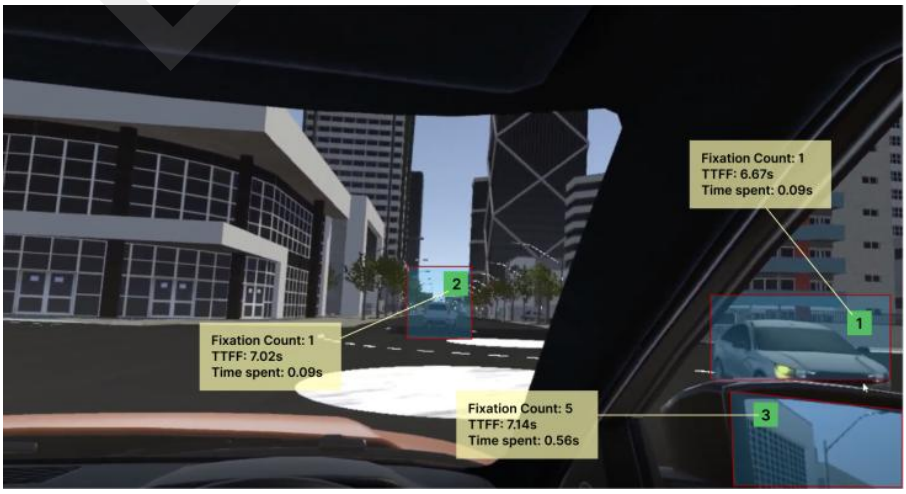

Figure 2. Eye-tracking fixation sequence during a failed double-roundabout scenario Source: Author's own work

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Figure 2 illustrates a representative case in which a participant failed the double-roundabout scenario. Eye-tracking observations showed that some drivers visually attended to hazards yet still failed the scenario, suggesting that performance breakdowns were driven more by incorrect mental models or procedural knowledge gaps than by attentional omission. Areas of Interest (AOIs) were defined within the Unity environment to encompass other road users, traffic signs and lights, and the in-car rear-view mirrors. In addition, the relatively short dwell time across key AOIs, typically falling below the 0.15s threshold required for deep cognitive processing (Schleicher *et al.*, 2008), indicates a hurried decision process, suggesting drivers may revert to default driving schemas under complex traffic conditions. As a result, the participant turned right after the first roundabout stage, ignored the second circular flow, entered the opposing lane, and failed to signal appropriately. Such behaviour represents a critical safety risk, as real-world incidents in the UK have demonstrated that driving on the wrong side of the road can lead to fatal outcomes; for example, the widely reported case involving Anne Sacoolas highlighted the severe consequences of lane-direction errors linked to differences between left- and right-hand traffic systems (BBC News, 2022).

Benefits to road safety

This study provides objective evidence on how overseas drivers interact with unfamiliar traffic systems using behavioural logging and eye-tracking within an immersive VR environment. The findings identify high-risk scenarios, particularly roundabouts and complex signalised intersections. By distinguishing between knowledge gaps and attentional misallocation, the study supports targeted, evidence-based safety interventions and offers a transferable framework for investigating cross-cultural driving risks. The VR platform also enables safe exploration of near-miss behaviours without exposing road users to real-world danger, supporting proactive road safety improvement.

Implications for policy and/or practice

Findings suggest overseas drivers may benefit from structured preparation when adapting to UK driving environments, especially for roundabout navigation, signalling conventions, and lane positioning. Immersive VR platforms could serve as pre-driving familiarisation or assessment tools to identify risky behaviours before real-road exposure. Eye-tracking results further indicate that interventions should address both rule knowledge and attention strategies in complex environments. These findings support the development of targeted training materials and adaptive licensing support to reduce early adaptation risks. However, technology alone has clear limitations regarding scalability and simulator sickness. Beyond digital solutions, policymakers could introduce a short, mandatory training course. Furthermore, non-technological interventions like intuitive road and roundabout engineering can reduce driver cognitive load.

Conclusions

This paper presents a VR eye-tracking platform for exploring behavioural and attentional mechanisms among overseas drivers adapting to UK traffic systems. Results showed that complex roundabout scenarios generated the lowest success rates, while signalling and traffic-light misunderstandings were frequent violations. Eye-tracking observations suggested that some failures were linked to knowledge gaps despite adequate hazard attention. The study demonstrates the value of combining immersive VR and gaze analytics to generate actionable evidence for road safety. Future work will expand sample size and integrate machine learning to analyse eye-tracking data in the platform to further inform intervention design.

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DRAFT

Evaluation of WA's School Zone and Children's Crossing Program

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Abstract
The Western Australia School Zone and Children's Crossing Program, funded by the Road Trauma Trust Account, aims to reduce road trauma among children through a Safe System approach focused on speed management and road user behaviour. In 2024/25, the program expanded from school zones to include 40 km/h variable speed limits at Children's Crossings outside school zones, strengthening road safety and supporting active travel initiatives. This evaluation applied a mixed-methods approach, including stakeholder surveys, crash analysis, telematics data, and site-based case studies. Telematics data demonstrated reduced speeds during variable speed limit periods and trend towards increasing compliance. Community and traffic wardens' perceptions of road safety and variations across locations highlighted the importance of context-sensitive implementation. Findings from early months of implementation provided evidence informing the program over the next three years. Overall, the program contributes to improved speed management, safer school environments, and broader objectives promoting active travel.

Introduction
Transport-related injuries continue to be the leading cause of injury-related deaths among children aged 0–14 years (AIHW, 2022). Children's developmental, cognitive, and physical characteristics heighten their vulnerability as road users while vehicle speed remains a critical determinant of both crash risk and injury severity. In Western Australia (WA), the five-year average killed or seriously injured (KSI) rate for children aged 0-16 is 19.1 per 100,000 population (Road Safety Commission, 2024). Around 25% of KSI for children (0-16) occurs during peak school travel times (Road Safety Commission, 2026). Despite substantial investment in infrastructure, regulation, enforcement, and education initiatives, improving the safety of children in and around school zones remains a persistent road safety challenge. High traffic congestion, inconsistent active-transport infrastructure and excess speed are among the concerns for road safety around schools. School zones are designed to mitigate this risk through reduced speed limits during peak school travel periods, lowering vehicle speeds and increasing driver awareness of children's presence. Evidence demonstrates that school zones are effective in reducing average vehicle speeds (Thompson et al., 2025) and electronic (flashing) speed limit signs relative to static signs have beneficial effects in drawing driver's attention (Transport and Main Roads, 2014).

The WA School Zone and Children's Crossing Program, funded by the Road Trauma Trust Account (RTTA), installs and maintains static and electronic school zone signage across the State. In 2024–25, the program expanded to establish 40 km/h variable speed limits during peak school travel times around Traffic Warden Controlled Children's Crossings, with electronic signage on 60–70 km/h roads and static signage on 50 km/h roads. Crash data (2017-2021) identified approximately 1,500 reported crashes at or near Traffic Warden Controlled Children's Crossings, with crash likelihood 27 times higher at crossings located outside designated school zone areas compared with those within existing School Zones (Main Roads Western Australia, 2023). The program, underpinned by Safe System principles, recognises speed management as central to reducing the likelihood and severity of crashes. Beyond speed management outcomes, the initiative seeks to enhance both actual and perceived safety, reduce barriers to active travel, and support traffic wardens who provide essential and highly valued services within local communities.

With the program expansion to Children's Crossings, a comprehensive evaluation framework was developed to assess the program's contribution to community perceptions, driver behaviour and overall road safety benefits. This presentation outlines the WA School Zone and Children's Crossing Program and presents findings from telematics data analysis and stakeholder surveys in the first year of implementation of the expanded program. The results are discussed together with location specific case studies highlighting the programs contribution to broader road safety outcomes and how this evidence informs targeted road safety responses and investments.

Conference theme
This project illustrates the translation of evidence into action by applying robust, mixed-methods evaluation to inform and strengthen road safety investments. By integrating crash data, site specific analysis, connected vehicle data, and stakeholder insights, the evaluation generated actionable findings that directly informed program refinement and

investment decisions. Importantly, the evaluation framework embeds early consultation and stakeholder buy-in, ensuring that findings were used and applied through the life cycle of the project. In doing so, the project supports safer school environments, enables active travel, and contributes to a brighter future where data-driven decision-making enhances child safety and community wellbeing.

Method

The evaluation was a collaboration between two State Government agencies and an independent evaluation team. The evaluation, conducted between September 2025 and February 2026, aimed to assess the effectiveness of the expanded WA School Zone and Children's Crossing Program. A mixed methods framework was applied, seeking to compliment the strengths of geo-spatial analysis utilising telematics and crash data with rich contextual information on existing road safety infrastructure, transport initiatives and stakeholder perspectives.

The primary outcome measures were 85th percentile speed and speed limit non-compliance. Data from all expanded program sites was included in the before-after analysis, with sub analysis by location, road characteristics and sign type. A pragmatic sample of ten location-specific case study sites were used to better understand how environmental and contextual factors influence program effectiveness and outcomes. In addition to the primary outcome measures the case studies included infrastructure characteristics, traffic and pedestrian volumes, crash and safety trends and active transport initiatives. Survey was used to understand the level of awareness of speed limit changes, perceptions of road safety and behavioural impacts of the program. On-line surveys for community members and traffic wardens were administered separately and returned 407 and 499 responses respectively.

Findings

Eighty-fifth percentile speeds showed a reduction in the post implementation period (August to November 2025) compared with the equivalent months in 2023 and 2024. This trend was observed for both morning (7.30am to 9am) and afternoon periods (2.30pm to 4pm). Analysis by signposted (usual) limit and sign type showed lower 85th percentile speeds at sites with electronic speed limit signs relative to those with static signs and marginally better compliance on roads that are of a lower signposted speed. Across all sites, however, the 85th percentile remained around 10km/h above the limit of 40km/h. Non-compliance with the variable 40km/h zone, November 2025, was 40% on 50km/h roads, 56% on 60km/h roads and 60% on 70km/h roads. These findings are reported for the initial period of speed zone changes when driver behaviour adaptation is typically in a change phase. Demonstrating further actions are needed to address driver behaviour change, this early evaluation provided evidence informing roll-out over the remaining three years of the program.

Ten case studies explored site-specific factors including infrastructure characteristics, traffic and pedestrian volumes, crash and safety trends and active transport trends. Collectively, these studies highlight the diversity of Children's Crossing environments and the dynamic relationships between driver behaviours, traffic conditions, infrastructure, and community factors.

The level of driver awareness of speed limit changes, surveyed in November 2025, was low to moderate (39%) and, amongst those 72% reported they had reduced their speed in Children Crossing zones. However, 59% community drivers believed it was common for drivers to exceed 40km/h while around 44% of traffic wardens observed most or all drivers appearing to exceed the speed limit. Survey results and stakeholder feedback highlighted police enforcement, signage and better road markings and improved community education and awareness could further improve safety. Traffic congestion and driver inattention were among the community concerns for road safety of children walking, cycling and wheeling to school.

Benefits to road safety

Children are amongst our most vulnerable pedestrians and the road environment in and around schools is diverse and dynamic. This initiative, expanded from school zones to include Children's Crossings outside school zones, strengthens road safety for children crossing the road in complex environments where road speeds are higher, and in multilane and varied traffic environments.

Implications for policy and/or practice

The evaluation of the expansion of 40km/h speed zones demonstrates how evidence on speed risk, compliance, and environmental context can directly shape targeted road safety policy and practice. By providing evidence of the effectiveness of the expanding 40hm/h variable speed zones to Children's Crossings situated outside school zones, the evaluation has provided a rationale for speed management to mitigate risk and improve road safety.

Creating safer environments for children walking, cycling and wheeling to school requires system-wide and multifaceted responses. Developing the program's evaluation framework highlights the value of early consultation, strong stakeholder engagement, and organisational commitment to ensure that evidence is meaningful and actionable.

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Our presentation offers insight for project managers embedding road safety evaluation and feedback loops during the life of the projects and translating evidence to continuous improvement and informed decision making.

Conclusions

Grounded in Safe Systems principles the WA School Zone and Children's Crossing Program addresses the important area of road safety for children. The expansion of the program prompted the development of a robust evaluation framework designed to understand the program's influence on community perceptions, driver behaviour and overall road safety benefits.

Evaluation findings, interpreted through a lens of Safe Systems thinking, speed management policy, child safety and active travel, show early behavioural shifts towards lower speeds. Whilst non-compliance within the 40 km/h zone was observed, the evaluation occurred within the initial months of speed zone changes when driver behaviour adaptation is typically in a change phase. The results underscore the importance of communication and change management strategies supporting infrastructure and speed zone changes. Overall, the evaluation provided insight into factors influencing the safety of children walking, cycling and wheeling to school.

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Testing of Red Light and Pedestrian Warnings Using C-ITS

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Abstract

Red light violations and turning conflicts with pedestrians remain persistent contributors to serious injury and fatal crashes at signalised intersections. This study presents early findings from controlled real-world testing of Red Light Violation Warning (RLVW), Time to Green Warning (TTGW), and Pedestrian Turn Warning (PTW) applications using Cooperative Intelligent Transport Systems (C-ITS) at the Future Mobility Testing and Research Centre (FMTRC). A fully instrumented vehicle was tested under three conditions: C-ITS enabled, Autonomous Emergency Braking (AEB) only, and collision (no intervention). Deliberate pedestrian-target collision scenarios were conducted in a closed environment to compare intervention timing, braking profiles and stopping distances. Results demonstrate that C-ITS warnings consistently provided earlier driver notification than perception-based AEB alone, enabling smoother deceleration and preventing intersection entry under red phases. These findings highlight the value of testing failures in a closed environment and anticipatory safety layers in reducing intersection-related trauma.

Introduction

A study by Austroads, 2017 found that 30% of severe injuries occur at intersections, with urban signalised intersections identified as having one of the greatest contributions. Red-light violations and turning conflicts occur at signalised intersections, thus greatly contribute to fatal and serious injury crashes across Australia. While Advanced Driver Assistance Systems (ADAS), including Autonomous Emergency Braking (AEB), provide reactive crash mitigation, they rely on perception-based detection that may be limited by occlusion, latency or environmental conditions. Cooperative Intelligent Transport Systems (C-ITS) offer an anticipatory safety layer by transmitting real-time Signal Phase and Timing (SPaT), intersection geometry (MAPEM) and pedestrian phase information directly from infrastructure to vehicles. Previous large-scale initiatives (e.g. euroFOT, AIMES, ICVP) demonstrate the importance of live operational testing to validate connected safety systems beyond simulation.

This study presents controlled real-world validation of intersection warning applications under time-critical scenarios, bridging the gap between laboratory validation and open-road deployment.

This study investigates the effectiveness of key Cooperative Intelligent Transport Systems (C-ITS) safety applications, Red Light Violation Warning (RLVW), Time to Green Warning (TTGW), and Pedestrian Turn Warning (PTW) through controlled, live testing at the Future Mobility Testing and Research Centre (FMTRC) in New South Wales. These applications rely on infrastructure-to-vehicle communications to deliver real-time warnings based on traffic signal states, intersection geometry, and road user behaviour.

Unlike benchtop simulations or passive field studies, this trial was conducted in a controlled but realistic environment, enabling systematic evaluation of how connected vehicle systems respond under hazardous and time-critical conditions. A fully instrumented vehicle, Euro NCAP Pedestrian Target (EPT), and adaptive traffic signals were used to recreate high-risk intersection scenarios.

The primary objective is to assess how these C-ITS warnings influence driver behaviour and vehicle response in comparison to conventional ADAS, such as Autonomous Emergency Braking (AEB). Of particular interest is the performance of C-ITS in conditions where perception-based systems alone may be limited due to occlusion, latency, or adverse environmental factors. The findings provide critical insight into the operational timing, reliability, and interaction between C-ITS messages and vehicle systems.

Previous research has consistently emphasised that in-field validation is essential for understanding how C-ITS applications perform in realistic traffic contexts. Large-scale initiatives such as euroFOT and the Australian Integrated Multimodal EcoSystem (AIMES) in Melbourne have demonstrated that simulation or hardware-in-the-loop testing alone cannot capture the combined effects of human response, communication latency, and environmental uncertainty inherent to connected systems (AIMES 2021 and euroFOT 2013). These real-world living laboratories provide the critical intermediate step between digital validation and open-road deployment, ensuring that connected messages are verified under representative conditions.

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In Australia, the Ipswich Connected Vehicle Pilot (ICVP) in Queensland has further demonstrated the value of large-scale, real-traffic trials for evaluating C-ITS performance at signalised intersections (ICVP 2022). The pilot captured naturalistic vehicle data to assess communication reliability, driver response to in-vehicle warnings, and prediction of red-light violations, underscoring the necessity of live operational testing for safety-critical applications.

More recently, Kavas-Torris (2023), extended hardware-in-the-loop simulation into on-road testing for a RLVW application, validating communication performance and driver response under controlled red-light scenarios. Similarly, the Australian Centre for Field Robotics (ACFR) has conducted extensive work in cooperative and connected vehicle research, including perception-augmented communication systems, roadside sensing, and infrastructure-to-vehicle interaction studies (ACFR 2020). These collective efforts reinforce that real-world testbeds are essential to evaluate both the reliability of C-ITS message delivery and the behavioural impacts of connected safety applications.

While some prior studies have examined RLVW, Green Light Optimal Speed Advisory (GLOSA), and PTW systems in simulation or open-road pilot environments (e.g. Compass4D, AIMES, and ICVP), few have recreated these high-risk scenarios using physical pedestrian targets and instrumented vehicles under fully synchronised, signalised conditions. By conducting structured in-field trials at the FMTRC, this research bridges the gap between simulation-based validation and uncontrolled public-road testing, providing an evidence base for how connected warnings interact with driver decision-making and onboard ADAS systems.

This evidence supports the growing consensus that controlled, real-world testing is a necessary complement to digital or model-based validation when assessing cooperative safety functions. As highlighted by global initiatives such as euroFOT, AIMES, and ICVP, only through bounded real-world environments can system timing, message consistency, and cross-platform interoperability be comprehensively validated. The present work therefore contributes new data and insight on how infrastructure-supported warnings can enhance intersection safety for vulnerable road users under real-world operating conditions.

Conference theme

This work aligns with the ARSC 2026 theme *From Evidence to Action: Shaping a Brighter Future* by translating empirical real-world testing into actionable safety insights for deployment of connected vehicle technologies. The findings provide evidence to support integration of infrastructure-supported warnings as a complementary safety layer to perception-based systems, informing deployment, regulation and infrastructure investment decisions.

Method

Testing was conducted in October at the FMTRC in Cudal, NSW, at a fully signalised four-way intersection equipped with SCATS C-ITS integration. A 2016 Volkswagen Passat fitted with a Cohda MK5 On Board Unit (OBU) and Human–Machine Interface (HMI) was instrumented with GNSS-based VBOX logging, synchronised video and roadside communication logs. A Euro NCAP Pedestrian Target (EPT) mounted on a robotic LaunchPad simulated vulnerable road users. Three RLVW conditions were tested at 40 km/h:

1. C-ITS Enabled – Infrastructure messages triggered early warning.
2. AEB Only – Perception-based emergency braking response.
3. Collision – No intervention.

Results

Nine RLVW trials (three per condition) and additional PTW trials were conducted. Key variables included warning timing, deceleration profile, stopping distance and intersection entry behaviour:

- C-ITS enabled runs produced earlier driver response and controlled deceleration from 40 km/h to stationary prior to the stop line.
- AEB-only runs entered the intersection during red and required sharp, high-force braking before stopping.
- Collision runs showed no braking intervention and resulted in target impact at speed.

Acceleration and velocity traces demonstrate smoother deceleration curves under C-ITS compared to abrupt AEB intervention PTW trials confirmed vehicles remained stationary during active pedestrian phases and only proceeded once safe to do so. These results indicate that cooperative messaging extends the “safety horizon” beyond reactive perception-only systems.

Benefits to road safety

The FMTRC’s tests confirmed that connected messages could be reliably broadcast and received with low latency. RLVW consistently delivered timely warnings to support deceleration under cruise control. TTGW and PTW alerts were accurately timed to traffic light changes and pedestrian phases. Emergency braking successfully engaged when EPT were detected, validating its synergy with perception-based systems.

Across the trials, vehicle AEB systems demonstrated reliable triggering when imminent collisions were detected

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through onboard perception sensors. In mixed-mode configurations, where C-ITS messages (e.g. SPaTEM, MAPEM, and Cooperative Awareness Message) informed the vehicle's decision logic, AEB was not required to intervene, as vehicles were able to adjust trajectories or speeds in advance of hazardous conditions. This finding reinforces the role of cooperative awareness in extending the vehicle's 'safety horizon'
(Bazzi, Masini, & Zanella, 2017), allowing earlier situational interpretation and smoother, more controlled responses.

While AEB remains an essential final layer of defence, it is inherently reactive. It intervenes only at the point where a collision is unavoidable without emergency deceleration. By contrast, C-ITS functions as a pre-emptive, higher-order safety layer that enables proactive control well before such situations occur. Through early access to infrastructure and network data, connected warnings allow vehicles to decelerate predictably and stop safely before reaching the conflict zone. A vehicle that triggers its AEB is already within a failure state responding to an immediate hazard, whereas a connected vehicle receiving a RLVW can avoid that failure entirely by never entering the intersection under a red phase.

This distinction highlights the evolution from reactive safety to anticipatory safety. Rather than relying on last-minute avoidance, C-ITS enables cooperative foresight where vehicles and infrastructure share intent and timing, creating smoother braking profiles, improved comfort, and reduced abrupt interventions. Most notably, the collision trials enabled by FMTRC's unique infrastructure provided a rare opportunity to observe safety outcomes in critical failure scenarios.

Implications for policy and/or practice

Real-world validation demonstrates that infrastructure-supported warnings complement AEB rather than replace it, strengthening a Safe System approach.

Conclusions

The FMTRC trial demonstrated that a controlled, real-world test environment is critical for the validation of connected intersection safety systems. Applications such as RLVW, TTGW, and PTW were successfully triggered in alignment with signal phases, confirming their functional integration with both infrastructure and in-vehicle systems.

The incorporation of deliberate collision scenarios, executed within a safe and structured framework, provided essential insights into system behaviour under edge-case conditions. These trials revealed limitations in perception-only approaches and highlighted the value of infrastructure-supported warnings in mitigating risk. Such outcomes cannot be reliably captured through benchtop testing or passive field observation alone.

Future work must continue to prioritise live testing under varied and hazardous conditions. These trials enable a deeper understanding of the interaction between vehicle systems, road infrastructure, and vulnerable road users, particularly when evaluating emergency response timing, signal synchronisation, and message reliability. Real-world validation is fundamental to progressing the safety and robustness of C-ITS deployments at scale.

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Heavy-vehicle and vulnerable road user safety using AI-based video analytics

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Abstract
Heavy vehicles (HVs) pose significant crash risks to vulnerable road users (VRUs), particularly during complex interactions at urban intersections. Despite their distinct operational characteristics, the nature of heavy vehicle interactions with vulnerable road users remains insufficiently understood. This study investigates the interactions between HVs and VRUs at signalised intersections by applying Artificial Intelligence (AI)-based video analytics. For this purpose, video data from eight signalised intersections in Queensland were analysed using traffic conflict techniques to identify HV-VRU critical events and their interaction patterns. Results indicate that the presence of heavy vehicles disproportionately elevates VRU risk, with higher conflict rates than NonHV-VRU interactions and approximately three times the severity, particularly at permissive turning movements and unmarked slip lanes. The findings provide evidence to guide interventions and policy for reducing HV-VRU crash risk.

Background
Heavy vehicles represent a disproportionately high-risk road user group due to their unique operational characteristics, including greater mass, longer braking distances, larger turning radii, slower acceleration and deceleration capacity, and extensive blind spots, particularly in complex intersection environments involving vulnerable road users. Queensland Crash data from 2016 to 2023 identified 479 HV-VRU crashes, with nearly 63% resulting in fatalities or hospital injuries. Around 40% of these crashes occurred at intersections, where 64.2% resulted in fatal or serious injuries, highlighting intersections as critical environments for HV-VRU crash risk (Queensland Government, n.d.). Traditional crash-based safety assessments are inherently reactive, that identifies interventions for hazardous locations only after crashes have occurred. In contrast, proactive approaches, particularly traffic conflict techniques, enable the evidence-based analysis of dynamic interactions and high-resolution behavioural data to predict risks before crashes occur. Recognising these challenges, proactive analysis is essential to generate data-driven insights that inform targeted mitigation strategies for improving vulnerable road user safety in interactions with heavy vehicles.

Conference theme
This study aligns with the conference theme *"From Evidence to Action: Shaping a Brighter Future"* by translating empirical evidence on heavy vehicle-vulnerable road user (HV-VRU) interactions into practical safety insights. Recent advances in traffic conflict techniques have demonstrated that conflict measures can provide reliable estimates of crash risk and valuable insights into unsafe interactions before crashes occur (Arun et al., 2021).
By providing a comprehensive assessment of HV-VRU interaction patterns and risk conditions, using traffic conflict techniques, the study proactively generates evidence to support more informed design, operational, and policy decisions aimed at improving road user safety.

Method
Based on crash history, road user volumes, and stakeholder consultation, eight intersections in Brisbane and Gold Coast (Queensland) were selected for the study. A total of 873 hours of video were collected using pole-mounted cameras at 8 m height, of which data for seven consecutive days per intersection were used for analysis. An AI-based traffic conflict extraction technique was employed to automatically extract the traffic conflict from video footage. The automated process involved three major phases, a) object detection and tracking, b) trajectory generation, and c) traffic conflict extraction, as illustrated in Figure 1.

The most prevalent traffic conflict measures, post encroachment time (PET) for vulnerable road user (VRU) conflicts (crossing-course type such as right-turn conflicts), and Modified Time-to-Collision (MTTC) for longitudinal interactions or Non-VRU conflicts (collision-course type such as rear-end conflicts) were used in this study (Arun et al., 2021; Howlader et al., 2024). PET and MTTC thresholds of 4.0 s and 3.0 s were adopted to capture safety-critical events, consistent with thresholds commonly used for crash risk analysis in previous studies to ensure that all extreme events are captured while minimising needless data processing (Zheng & Sayed, 2019).

a) **Object detection and tracking**

b) **Trajectory generation**

c) **Traffic conflict** extraction

Figure 1. AI-based video analytics platform for road user tracking and conflict identification.

Crash probability was estimated using the Crash Potential Index (CPI) derived from the Deceleration Rate to Avoid Crash (DRAC) and Maximum Available Deceleration Rate (MADR) [considering truncated normal distribution for NonHV ~ N(8.45, 1.40) I(4.23, 12.69) and HV~ N(5.01, 1.40) I(2.05, 7.98) (Zhao & Lee, 2018)]. Furthermore, crash severity was estimated using binary logistic regression models of MAIS3+ injury (severe or fatal) probability developed by Schubert et al. (2023) based on pedestrian-heavy vehicle crash reconstruction data.

The analysis followed three main stages. First, conflicts were categorised at the system level to examine whether heavy vehicle (HV) presence is associated with elevated vulnerable road user (VRU) conflict exposure within intersection traffic environments. Second, a VRU-focused comparison was conducted between HV-VRU and NonHV-VRU interactions to evaluate differences in observed conflict severity, estimated crash probability, and post-crash injury risk, while also comparing kinematic behaviour of heavy vehicles and other vehicles in response to VRU movements. Third, detailed conflict mapping was undertaken to identify spatial, temporal, and geometric patterns of HV-VRU conflicts across intersections This integrated analysis provided a comprehensive understanding of HV-VRU risk patterns and contributing factors at signalised intersections.

Findings

Analysis identified 387 traffic conflicts involving heavy vehicles (HVs), of which 111 involved vulnerable road users (VRUs) compared to 1802 VRU involvement in total 10126 NonHV conflicts. Although HV conflicts were fewer overall, the proportion involving VRUs was significantly higher than expected ($\chi^2 = 29.7$, $p < 0.0001$), indicating that HV presence disproportionately elevates VRU conflict risk. However, mean value of post encroachment time conflicts for HV-VRU (3.20 s) was significantly higher than for NonHV-VRU conflicts (2.91 s) indicating lower observed conflict severity for HV-VRU interactions. After normalising conflicts by traffic exposure, the HV-VRU conflict rate was approximately 2.5 times higher than NonHV-VRU conflicts (Poisson rate ratio = 1.62, 95% CI: 1.34–1.96, $p < 0.001$) (see Figure 2).

Crash probability estimated based on Crash Potential Index (CPI) indicated similar annual crash frequencies for HV-VRU (0.956) and NonHV-VRU (1.004) interactions. However, estimated severe HV-VRU crash risk probability (0.222) was approximately three times higher than NonHV-VRU severe crash risk probability (0.082). These findings are consistent with previous studies reporting low likelihood but disproportionately higher injury severity in heavy vehicle crashes, largely due to their greater mass and momentum, higher braking distance, and limited manoeuvrability, which increase impact forces during collisions (Hu et al., 2024).

Kinematic analysis indicates distinct behavioural differences in heavy vehicle (HV) interactions with vulnerable road users. Heavy vehicles showed lower and flatter approach speed than NonHVs during the post encroachment window. Braking response timing and deceleration proportions were similar, but HVs showed greater acceleration-deceleration fluctuations, reflecting constrained manoeuvrability and operational limitations during interactions with VRUs.

Spatial analysis across key intersection geometric configurations, including permissible turning approaches, through approaches, unmarked, marked, and signalised slip lanes, revealed pronounced differences in heavy vehicle-vulnerable road users (HV-VRU) conflict rates compared to NonHV-VRU conflict rates when normalised per 1000 heavy vehicle volume (**Figure 2**). Permissible turning approaches recorded the highest HV-VRU conflict rate (37.58), substantially exceeding corresponding NonHV-VRU rates (1.07), followed by unmarked slip lanes (HV-VRU: 17.33; NonHV-VRU: 5.33). Notably, unmarked slip lanes accounted for around 55% of the HV-VRU conflicts (61 out of 111). At unmarked slip lanes, the lack of formal crossing control may lead to higher operating speeds and reduce driver yielding behaviour. Similarly, permissive turning movements create complex decision-making environments where drivers focus on vehicular gaps while potentially overlooking vulnerable road users crossing the roadway. Permissible turning approach

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and unmarked slip lane also exhibited higher HV operating speeds (up to 38.29 km/h at unmarked slip lanes and 30.34 km/h at permissive turns), with elevated risk during early morning (07:00-08:00) and mid-to-late afternoon (15:00-18:00) periods. The higher operating speeds observed may reflect limited driver awareness of VRU right-of-way conditions, while the temporal elevation of risk may indicate the variations in driver attention, traffic flow conditions, and decision-making behaviour during morning and afternoon peak hours.

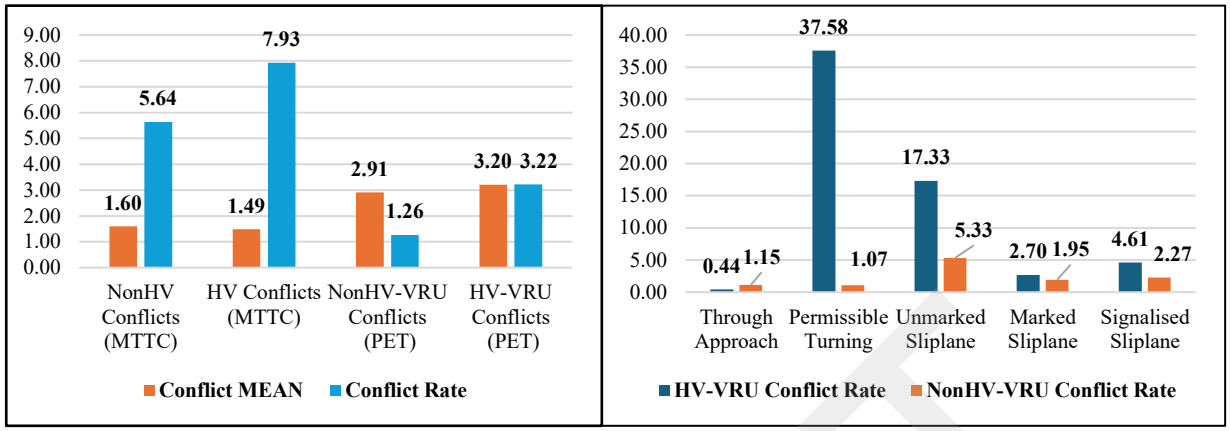

Figure 2. Comparative rates and spatial distribution of HV-VRU and NonHV-VRU conflicts.
Note: PET= Post Encroachment Time; MTTC = Modified Time to Collision; HV = Heavy Vehicle; VRU = Vulnerable Road User

Benefits to road safety

This study provides insights into heavy vehicle-vulnerable road users (HV-VRU) interactions by integrating advanced analytical technologies with predictive safety assessment approaches. The analysis develops a comprehensive understanding of HV-VRU interactions by identifying the nature, patterns, and consequences of such events. These findings provide critical evidence to recognise the significance of HV-VRU safety at signalized intersections and to prioritise interventions aimed at reducing road trauma.

Conclusions

This study demonstrates the proactive approach for identifying heavy vehicle-vulnerable road users (HV-VRU) crash risks at signalised intersections by applying AI-based video analytics and traffic conflict techniques. The analysis revealed that HV presence disproportionately elevates VRU conflict risk at intersections and poses substantially higher injury severity risk compared to NonHVs. Spatial analysis also identified high-risk locations and interaction patterns, particularly at permissive turning approaches and unmarked slip lanes, highlighting the influence of intersection geometry and operational conditions. These insights provide practical guidance for improving heavy vehicle safety and reducing HV-VRU crash risks through targeted engineering, operational, and awareness interventions. Future work will expand the dataset and further develop structured risk management approaches to support broader application across different road environments.

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The negative effect on motorcycle clothing protection introduced by EN17092

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Abstract
In 2020 a new European Standard (EN17092:2020) was introduced to certify the protective performance of motorcycle gear. At the same time the Motorcycle Clothing Assessment Program (MotoCAP) was introduced in Australia and New Zealand to provide information on safety and comfort performance of clothing to riders. This research has utilised the MotoCAP performance metrics of impact abrasion resistance, seam burst strength and impact protection to evaluate the influence of EN17092 on the protective performance of motorcycle clothing. Approximately 60% of the gear available to riders in Australia and New Zealand is certified to EN17092. The protective performance of A and AA certified gear has reduced each year of analysis. Decreased protection of the high abrasion risk Zone 1 and medium risk Zone 2 is the key reason for the decrease in protection. A new riders first gear purchase may unknowingly expose them to a higher risk of serious injury.

Introduction
Three European standards have been used for the certification of protective motorcycle clothing. EN13595:2002 (CEN, 2002) was developed from the Cambridge University protective clothing standard. This standard was aimed at professional motorcycle riders with high requirements for abrasion, seam and tear strength protection levels. Its two pass levels were hard to achieve resulting in less than 5% of gear being certified to this standard. In 2012 the French government released a modified version of EN13595:2002 aimed at being more suitable for non-professional riders and is referred to as the French protocol. The lower levels of this standard and the enforcement by French Authorities for gear sold in France meant wider adoption of this variant by French manufacturers. In 2018 the provisional version of EN 17092:2020 (CEN, 2020) was released. From April 2018 the European Government started to enforce compulsory certification of motorcycle apparel sold in European Union stores. Initially manufacturers certified gear to all three standards however the introduction of EN17092:2020 also coincided with the withdrawal of EN13595:2002 and the French Protocol, meaning garments are now only certified to EN17092:2020.

EN17092 has five levels of certification: AAA, AA, A, B and C. A, AA and AAA garments are tested for impact abrasion resistance, tear strength, structurally strong seams and impact protection with graduated protection levels from A (lowest) to AAA (highest). Type B garments have the same abrasion, tear and seam requirements as a Type A garment however they do not require impact protection. Type C garments are designed for impact protection only and have different requirements for abrasion, tear and seam depending on if they are to be worn as an undergarment or overgarment.

Australia and New Zealand do not have a standard for testing motorcycle clothing. The Motorcycle Clothing Assessment Program (MotoCAP) was developed to provide information to riders on the protective performance of jackets, pants and gloves, and it started providing results to riders in August 2018. MotoCAP tests impact abrasion resistance, seam burst strength and impact protection (Hurren et al., 2022). The three protection elements are combined in an algorithm to calculate the protection score with a star rating assigned from half to five stars.

The key differences between EN17092 and MotoCAP are the methods for assessing abrasion and seam strength. For abrasion, MotoCAP uses the Cambridge test method (EN13595-2:2002), whereas EN17092 utilises the Darmstadt test method. The Cambridge method provides a time to hole enabling the differentiation between performance for a protective material. The Darmstadt method provides a Pass or Fail at one of five pre-defined speeds rather than providing a performance profile (Spädt et al., 2021). For seam strength, MotoCAP uses a hydraulic burst method whereas EN17092 utilises a tensile strength method.

This study utilised MotoCAP performance data of overall protection score, abrasion, burst and impact test results to evaluate the influence that EN17092 has had on motorcycle clothing protection performance.

Conference theme
Most riders assume that a motorcycle garment tested to the European Standard would provide them some levels of protection in a crash. This work is providing the ***evidence*** to enable ***action*** on reversing this negative effect on motorcycle clothing and thus ***Shaping a Brighter Future***.

Method

This study presents a comprehensive analysis of data collected over eight years from MotoCAP tests (averaging 110 jackets and pants annually) from the Australian and New Zealand market. 335 EN17092 A, AA and AAA garments were used in the evaluation. All results presented in this work are freely available on the MotoCAP website in the individual garment test reports. Test periods are referred to in business years (e.g., business year 2019 covers the 1st of July 2018 through to the 30th of June 2019). The Zone 1 and 2 referenced in analysis is the Zones defined in EN17092-1:2020. The Zone 1 area is the same for EN17092, EN13595 and MotoCAP.

Results

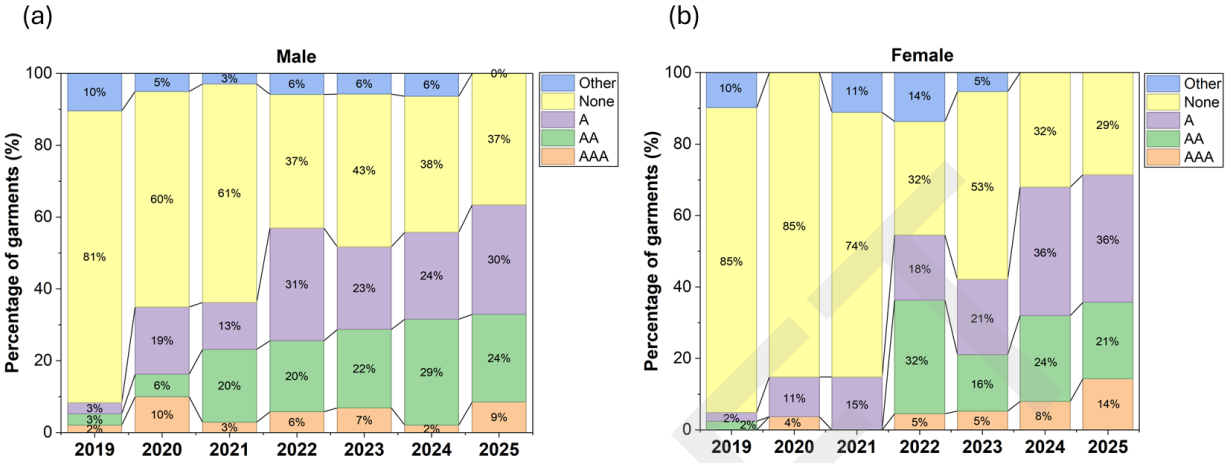

Figure 1. Percentage of garments certified by EN17092 (AAA, AA, A) from 2019 to 2025

Figure 1 illustrates the distribution of garments tested within the MotoCAP program according to various safety standards. These include EN 17092-2 (AAA), EN 17092-3 (AA), and EN 17092-4 (A). The "None" category represents garments with no formal certification, which primarily consists of domestic Australian and New Zealand brands. The “other” category represents the additional standards. In this analysis EN 17092-5 (B), EN 17092-6 (C), and EN 13595 and EN13595 French protocol are included. The analysis shows an increasing prevalence of EN 17092 samples within the MotoCAP program, reflecting the introduction of mandated testing in Europe flowing through to Australia. Approximately 60% of the gear purchased for the MotoCAP program was certified to EN17092 indicating the importance of the standard to Australian and New Zealand riders.

The protection levels of A and AA certified gear have been falling over the eight years evaluated by this research (Figure 2a). AAA certified gear has not been commented on as the number available in the market and tested by MotoCAP were too low for statistically significance analysis. The protection level had dropped approximately 20% for both A and AA certified gear over the eight years of evaluation. The MotoCAP abrasion score for A and AA certified gear both fell over the same test period with A falling 46% and AA falling 65% (Figure 2b). Seam strength results (not presented) remained flat over the same time for both A and AA gear. Impact protector performance (not presented) slightly increased for AA and initially decreased followed by an increase for A.

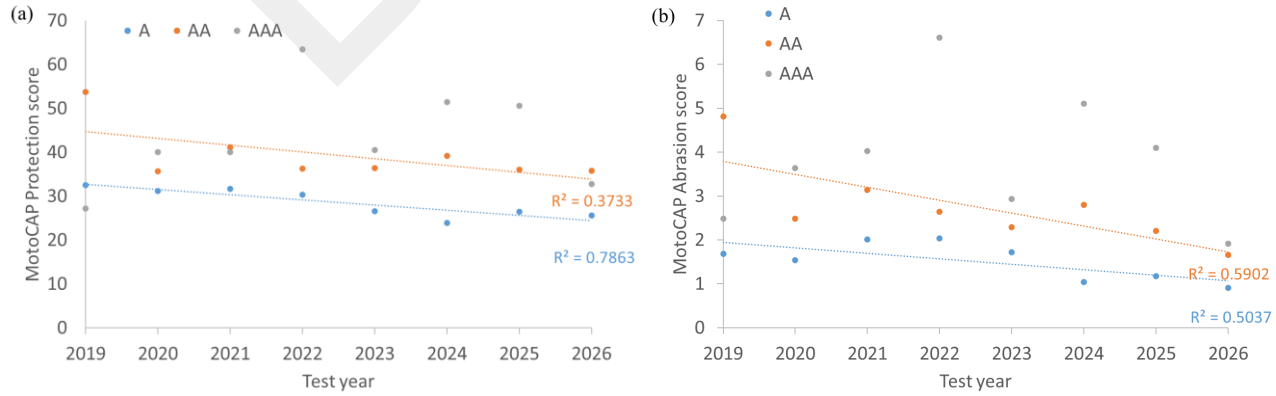

Figure 2. MotoCAP (a) protection scores and (b) abrasion scores for EN17092 garments

A deeper investigation into the abrasion performance of the high abrasion risk Zone 1 and medium abrasion risk Zone 2 areas of the garment found that these all decreased in performance for the A and AA certified garments (Figure 3a). All four parameters appear to be continuing to decrease and have not yet plateaued.

A scatterplot of all samples that were tested by MotoCAP and certified to EN17092:2020 is shown in Figure 3b. In the Zone 1 areas of EN17092-4:2020 (A) the Darmstadt test machine speed of 263 rpm correlates on this graph to a minimum abrasion time of approximately 0.35 sec on the Cambridge machine. For Zone 1 of EN17092-3:2020 (AA), the Darmstadt test speed is 412rpm and the minimum Cambridge abrasion time observed was approximately 0.60 sec. For the estimation of A and AA minimum pass times the lowest three results were discarded. For context a piece of denim fabric will achieve 0.4-0.6 sec of abrasion time on the Cambridge impact abrasion machine. The low value of these two pass times suggests that there is potential for the protection in the Zone 1 areas of A and AA to fall further. There are multiple examples of different manufacturers providing new models of garments with lower MotoCAP scores that the superseded older model. Evidence would suggest that manufacturers are reducing protection levels of materials to reduce garments cost and improve comfort.

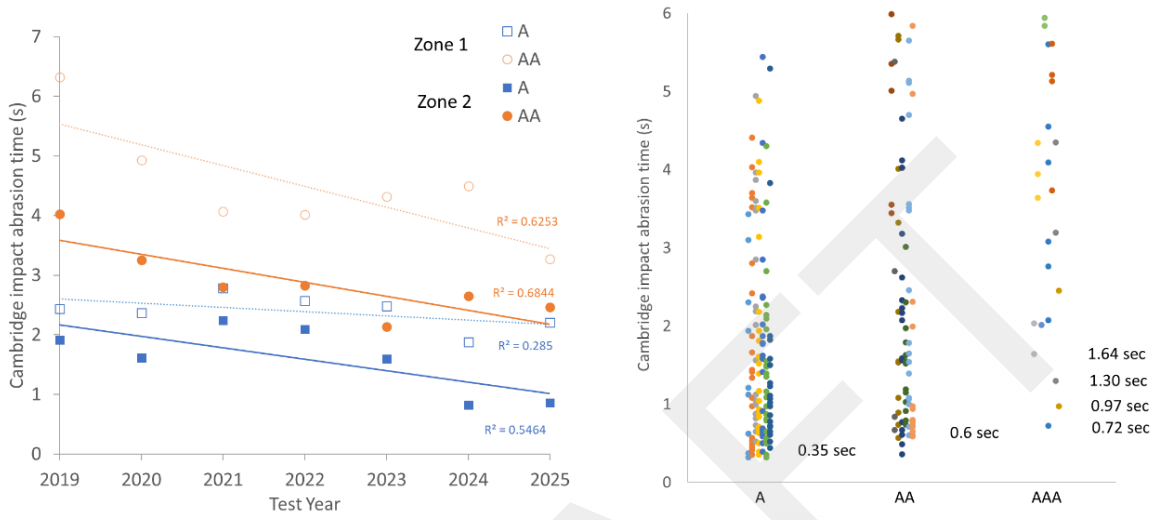

Figure 3. (a) Zone 1 and 2 abrasion times and (b) scatter plot of abrasion times for EN17092 Zone 1

Benefits to road safety

This research reveals a critical problem for the motorcycle riding community: the prevalence of gear offering low levels of protection. MotoCAP helps provide riders the discrepancies between evidenced-based protection performance and EN17092 certification levels.

Implications for policy and/or practice

This is a pressing issue for the riding community. Addressing it requires a concerted, multi-level effort to effectively communicate the risks to riders. There would be benefit in government interaction with standards authorities to highlight the implications of this lower performing standard and how it is affecting non-European riders.

Conclusions

Approximately 60% of clothing available in Australia is certified to the European Standard EN17092:2020. The protection level of gear has been falling since the introduction of the standard. The key reason for the fall in protection is the decrease in abrasion resistance of the materials provided in the high-risk Zone 1 and medium-risk Zone 2 areas of the garments. The minimum abrasion performance required to pass A and AA would suggest that there is still room for manufacturers to remove protection from their garments and still pass EN17092. Increased injury risk for motorcyclists will take several years to appear in crash statistics as riders hold onto gear for an extended period. The increased risk is more likely to appear in new riders who are buying gear for the first time and will be exposed to the lower performing gear from their first riding kilometer.

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Graduated licensing system countermeasures for older novice drivers in Victoria

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Abstract
Victoria's Graduated Licensing System (GLS) does not require licence applicants aged 21 and over (older novice drivers) to satisfy the full set of GLS requirements. Key differences in comparison to younger novice drivers (aged 18 to 20 years) include shorter Learner Permit and Probationary Licence holding periods and no mandated hours of supervised driving. Victoria's 2017 GLS Evaluation assessed the key GLS changes introduced across 2007/08. It found for younger novices there was a statistically significant reduction in their rate of involvement in fatal and serious injury crashes, and all injury crashes. However, for older novices there was no significant change in crash rates. A program of research, including a literature review, market research, economic analyses and systems thinking was undertaken to investigate possible GLS countermeasure improvements for older novice drivers. Findings included promotion of supervised practice hours and a four-year probationary period (with and without a peer passenger restriction).

Introduction
The Victorian Graduated Licensing System (GLS) does not require licence applicants aged 21 and over (older novice drivers), to be subject to the full GLS requirements. Key differences in comparison to younger novice drivers (aged 18 to 20 years), include shorter holding periods for the Learner Permit (12 months for younger novices, 6 months for those aged 21-25 years at licensing, 3 months for those over 25) and Probationary Licence (three years instead of four years) and no requirement for 120 hours minimum driving hours (including 20 hours at night) supervised by a fully licensed driver who does not have a BAC (Blood Alcohol Concentration) of .05 or above. Nor does the older novice driver have all of the associated GLS restrictions (specifically the P1 [first year] Probationary Licence peer passenger restriction and no towing) compared with the younger novice driver. Night-time driving restrictions do not apply to novice drivers in Victoria as per some jurisdictions. There are other GLS requirements, outlined on the Transport Victoria website.

Younger and older novices are overrepresented in road trauma. In 2024, drivers aged 18 to 25 years represented 11.8% of Victoria's licensed drivers on our roads; however, they accounted for 20.5% of drivers involved in fatal crashes. The Victorian 2017 GLS Evaluation that assessed key GLS changes introduced across 2007/08 (such as 120 hours supervision, the peer passenger restriction and four-year probationary period) found for drivers aged 18 to 20 years, there was a 20.3% reduction in their rate of involvement in fatal and serious injury crashes, and a 13.6% reduction for all injury crashes. These reductions were statistically significant. However, for drivers aged 21 to 23 years there was no statistically significant change in their crash rates (Healy et al., 2017). Hence, Road Safety Victoria, Department of Transport and Planning (RSV DTP) undertook a program of research to investigate possible GLS countermeasure improvements for older novice drivers.

Research indicates that both a lack of driving experience and driver immaturity (incomplete brain development) are responsible for the increased crash risk of novice drivers. For example, various research studies indicate that obtaining a minimum of 80 hours of supervised practice on the learner permit and up to 120 hours is the optimum amount to reduce crash risk once driving solo (Wundersitz et al., 2023). Other research indicates obtaining 120 hours of supervised driving experience is a very important component of the GLS, as those with 120 hours have 35% fewer crashes than those with 40-50 hours (Gregersen, 1997). Research evidence indicates that immaturity plays a role in the crash risk of young drivers. For instance, the frontal areas of the brain, which are essential for safe driving (e.g. impulse control, decision making, executive functioning) are not fully developed until around the age of 25 and possibly keep developing up to age 30. This alone is a critical consideration for applying GLS restrictions to novice drivers at least up to 25 years (Wundersitz et al., 2023). Although in Australia (and some US states) older novice drivers are observed to have lower crash rates than younger novice drivers, older novices have much higher crash rates than more experienced

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drivers of the same age. This finding is consistent with research reporting that novice drivers of all ages have high crash rates when first licensed. Therefore, both a lack of driving experience and incomplete brain development are important considerations for older novices (Wundersitz et al., 2023).

Considering the over-representation of younger and older novice drivers in road trauma compared with experienced drivers, and negligible impact of the revised GLS in 2007/08 on crashes of older novices, this program of research aimed to review the current GLS settings for those obtaining their licence from age 21.

Conference theme

This program of research addresses the ARSC2026 conference theme *From Evidence to Action: Shaping a Brighter Future* as it aimed to provide research evidence that could be translated into policy/countermeasure options to persuade leaders and politicians to undertake change to improve the safety of older novice drivers. There was collaboration throughout the project via a Project Advisory Group consisting of subject matter experts from the Victorian Road Safety Partners, RSV DTP and Registration and Licensing Management DTP.

Project description

The program of work involved four main research projects/phases undertaken by different researchers, and the policy work by RSV DTP across June 2023 to December 2025:

1. Literature review and jurisdictional scan (University of Adelaide – Centre for Automotive Safety Research)
2. Market research with young people and learner's supervisors/parents (ORIMA Research)
3. Economic analysis of countermeasures (Frontier Economics)
4. Systems thinking to explore countermeasures and their implications (Opposite [Systems Thinking]).

Findings

A narrative literature review was conducted targeting older novice driver research, identifying 17 studies published from 2007 to 2023, with empirical study quality assessed using a quality matrix rating system. An additional 55 studies were found through reference lists and grey literature. The jurisdictional scan involved undertaking interviews with Australian (n=4) and overseas jurisdictions (n=4). The main findings were (Wundersitz et al., 2023):

- Current research in the older novice driver space was sparse, hence some assumptions had to be made regarding the potential benefits of some countermeasures, as most evidence was often for a younger cohort.
- These countermeasures had the potential to support positive road safety outcomes for older novice drivers:
    - minimum mandatory supervised driving hours (at least 80 hours) on a learner permit
    - 12-month learner permit holding period
    - four-year probationary period (one year as P1, three years as P2) as opposed to the current three years
    - peer passenger restriction
    - nighttime driving restriction
    - licence disqualification for speeding offences during the probationary period.

The market research aimed to identify community sentiment towards the countermeasures identified from the literature review to determine levels of community acceptance, as well as to understand challenges for older novice drivers (ORIMA Research, 2024). This research found:

- Demographic characteristics and life situations differ considerably between younger and older novice drivers. As a result, older novice drivers were more likely to experience barriers to obtaining a licence than younger novice drivers, particularly those living outside the family home, which can limit access to supervisors or vehicles for practice. Older novice drivers also reported higher levels of financial cost barriers and anxiety about driving.
- Older novice drivers (particularly those not living with parents) are likely to be the most negatively impacted if minimum supervised practice hours are introduced.
- Minimum supervised practice hours under 120 hours, e.g. 60 to 80 hours (including practice hours at night), the 12-month learner period requirement and licence bans for repeat speeding offences over 10 km/h were the most strongly accepted countermeasures.
- Support was lower for the late-night driving curfew and a four-year probationary period (including a peer passenger restriction).

The economic analysis aimed to provide an understanding of the economic and social impacts of possible GLS changes for older novices, with a particular focus on a set of 13 individual and 6 combined countermeasures determined from the previous two phases of work and via consultation with RSV DTP and the research program's Project Advisory Group. Net beneficial countermeasures/packages in terms of road trauma reductions that outweighed costs for older novice drivers aged 21 to 25 years included (Frontier Economics, 2024):

- marketing/promotion of supervised practice hours
- four-year probationary period with and without a peer passenger restriction
- late night driving curfew (note – for all novice drivers, not just older novices) (10 pm – 6 am; first year of licensing only)

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- package of 12-month learner permit and four-year probationary period.

Countermeasures for older novice drivers aged 21 to 25 years that had a net cost and therefore were not beneficial to society included (Frontier Economics, 2024):

- Introduction of mandatory minimum supervised practice hours (either 50/80/120 hours) due to the greater inability to source a supervisor and vehicle to practice and the costs involved.
- A licence ban for a speeding offence (over 10 km/h) for the entire young novice cohort. However, including these speeding offences as part of the good driving record would provide a break even analysis crash reduction of approximately 10% per offender.
- Packages that involved supervision hours or were considered punitive in nature, e.g. 80 hours of supervised driving hours, 4-year probationary period, speeding offence ban, online behaviour change program and expanding the offences related to breaching the good driving record.

The systems thinking phase mapped the direct and indirect relationships between factors that contribute to younger (for completeness) and older novice driver crashes and near misses. It involved a desktop review of previous phases of research to determine key contributing factors and countermeasures to novice driver crashes. Novice driver personas were also created to represent the diverse user demographics, and a systems thinking map was used to visualise the direct and indirect relationships between contributing factors to crashes and near misses. The map revealed how interactions of factors create risk. For example, disadvantaged individuals living in rural areas may struggle to obtain the supervision hours, which culminates in decreased experience and higher crash risk. The systems map also assisted in visualising how external factors positively influence novice driver crashes such as policies and support systems (e.g. the L2P Program that provides access to a vehicle and a supervisor for disadvantaged youth). Overall the mapping exercise further validated the current importance of existing and proposed new/upgraded countermeasures for older novice drivers and provides useful context for planning any desired policy changes (Duck et al., 2025).

Benefits to road safety

If the recommended GLS countermeasures are implemented, they have the potential to reduce the road trauma of older novice drivers and other road users who are involved in their crashes.

Implications for policy and/or practice

There are a number of potential policy outcomes from this research program that are currently under consideration for implementation, as outlined below in the conclusions.

Conclusions

Overall, the program of research did not support the expansion of the full GLS, currently applied to younger novice drivers, to older novice drivers. However, a number of countermeasures were identified as potentially beneficial in reducing road trauma for older novice drivers, including promotion and campaigns to encourage more supervised learner hours, implementation of a four-year probationary period with the addition of the peer passenger restriction, a requirement to hold the learner permit for 12 months and a licence ban for a repeat speeding offence (over 10 km/h). Tensions were identified between the road safety evidence, economic impacts and community acceptance of certain countermeasures, particularly for increased supervised driving hours.

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Predicting drowsy driving impairment using smartphone app ocular-motor metrics

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Abstract
Drowsy driving is a leading cause of road crashes in Australia and globally. This study examined whether pre-drive ocular-motor assessment using a smartphone app (BrainEye™) could predict driving impairment induced by an acute period of sleep restriction. Eighteen participants completed a 20-minute simulated highway drive at baseline (well-rested) and again after four hours of overnight sleep restriction. Subjective drowsiness and ocular-motor measures of smooth pursuit (phase error, angular gain, and response latency) were assessed before each drive. An ocular-motor model of the data significantly predicted increased speed variability (Adj. $R^2 = 0.65$) and approached significance for lane-swerving (Adj. $R^2 = 0.26$), while subjective drowsiness predicted reduced average and maximum speed. Results indicate that ocular-motor parameters capture distinct aspects of driving impairment that self-report does not, potentially reflecting reduced cognitive capacity and vigilance. A smartphone-based pre-drive assessment tool may support individuals' decision-making about whether they are safe to drive after insufficient sleep.

Introduction
Driving while sleepy or fatigued poses a serious risk to road safety. Estimates suggest fatigue is a contributing factor in up to 20% of crashes in some jurisdictions (Thomas et al., 2021). Sleep loss, whether acute deprivation, chronic restriction, or fragmented sleep, increases the likelihood of daytime drowsiness. However, its impact on activities of daily living, including driving, varies substantially *between* individuals due to factors such as genetic predisposition (Viola et al., 2007) and habitual sleep patterns (Rupp et al., 2009), as well as *within* individuals because of contextual factors such as caffeine use (Bartrim et al., 2020) or accumulated sleep debt (Van Dongen et al., 2003). Consequently, simple metrics such as "hours slept" may be insufficient to predict functional impairment. More objective, individualised pre-drive assessment markers are needed.

Ocular-motor performance is highly sensitive to drowsiness. Sleep deprivation degrades smooth pursuit and saccadic movements (Fransson et al., 2008; Zils et al., 2005), and ocular-motor measures correspond with both subjective and objective indicators of sleepiness (Ahlstrom et al., 2013). Recent advances in smartphone-based eye tracking technology have made ocular-motor assessment increasingly accessible outside laboratory settings. Pre-drive application of such tools could provide an objective, individualised impairment signal to support safer driving decisions. As such, this study evaluated whether drowsiness-related driving impairment can be predicted using an ocular-motor behaviour model derived from smartphone-based smooth pursuit measures.

Conference Theme
This work directly addresses the ARSC2026 theme *'From Evidence to Action: Shaping a Brighter Future'* by demonstrating that evidence-based ocular-motor assessment can be operationalised through widely available smartphone technology, offering a practical pathway for scalable, individualised objective impairment assessment to support safer driving decisions and help reduce drowsy driving on Australian roads.

Method
The study was approved by the university's Human Research Ethics Committee (Ref No: 2024/416). Eighteen adults (14 males, 4 females; median age 24 years; median driving experience 6.5 years) with an Open class Australian driver's licence participated. The sample size was calculated based on a large effect size ($d_z = 0.8$, power = 0.8, $\alpha = .05$) for detecting changes in standard deviation of lateral position (SDLP) (Arnedt et al., 2005).

Testing spanned two consecutive days (Figure 1). On Day 1 (baseline, well rested), participants completed subjective ratings of sleepiness via the Karolinska Sleepiness Scale (KSS) and a smartphone smooth pursuit test (BrainEye™ app) before undertaking a 20-minute simulated highway drive in a fixed-base driving simulator. Participants were instructed to sleep for no more than four hours (10 pm – 2 am) that night. Compliance was verified using WHOOP 4.0 sleep tracking bands and a series of randomised email check-ins (including KSS and smartphone smooth pursuit tests)

overnight. On Day 2 (sleep-restricted), participants again completed the KSS and smartphone smooth pursuit test before the second 20-minute drive.

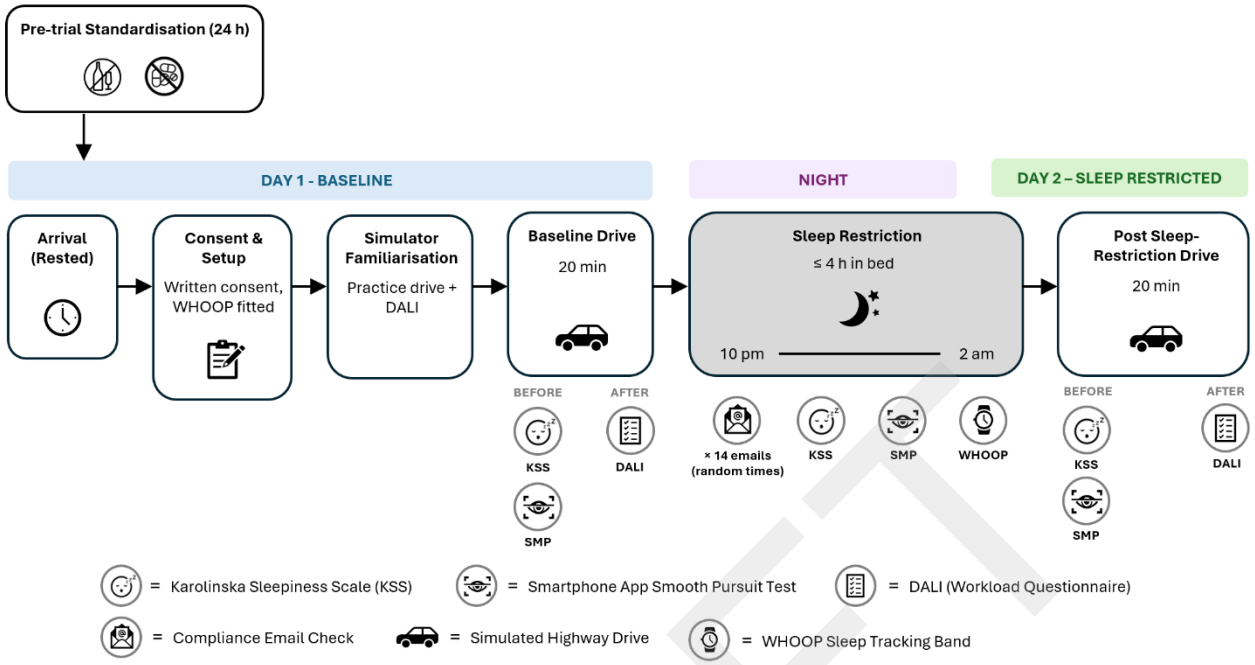

Figure 1. Study protocol timeline (two-day within-subjects design)

Three ocular-motor metrics were derived from the smartphone smooth pursuit test: Phase Error (mean angular deviation between eye and target), Angular Gain (ratio of eye to target angular velocity), and Mean Latency (time to change direction following target reversal). Driving outcomes were SDLP (lateral swerving), Average Speed, Maximum Speed, and SD Speed (speed variability). Subjective workload was assessed post-drive using the Driving Activity Load Index (DALI).

Repeated-measures *t*-tests compared baseline and sleep-restricted performance. Two multiple linear regression models per outcome variable were compared: an 'Ocular-motor model' (using changes in smartphone smooth pursuit metrics) and a 'Subjective model' (using change in KSS score). Model fit was compared using AIC, BIC, and Adjusted R^2.

Results

All but one participant had less than four hours of sleep (one participant slept 4 hours 7 minutes). Subjective drowsiness increased significantly from baseline (M = 3.4) to sleep-restricted (M = 5.6; $t(17) = 3.82$, $p < .001$, $d = 0.85$). At the group level, SDLP increased significantly (0.21 m to 0.27 m; $d = -0.97$), while no group-level changes in any of the speed parameters were observed (Table 1). High individual variability was observed for changes in all driving outcome measures. Perceived workload increased significantly across most DALI domains (effort, visual, auditory, situational stress).

Table 1. Simulated driving outcomes at baseline and following sleep restriction

Driving Outcome	Baseline	Sleep Restricted	*t*	*p*	Cohen's d_z
SDLP (m)	0.21 ± 0.06	0.27 ± 0.09	−4.35	<.001	−0.97
Avg Speed (km·hr^{-1})	113.3 ± 2.4	113.4 ± 2.7	−0.38	0.707	−0.09
Max Speed (km·hr^{-1})	124.4 ± 4.4	125.2 ± 5.0	−0.63	0.538	−0.14
SD Speed (km·hr^{-1})	4.2 ± 1.6	3.8 ± 1.1	0.89	0.387	0.2

SDLP = standard deviation of lateral position, SD = standard deviation, Values are Mean ± SD.

The ocular-motor model significantly predicted SD Speed ($F(3,14) = 10.79$, $p < .001$, Adj. $R^2 = 0.65$), with Mean Latency ($\beta = 0.59$, $p = .002$) and Phase Error ($\beta = -0.58$, $p = .002$) as significant predictors. The subjective model was a poor predictor of SD Speed (Adj. $R^2 < .001$). For SDLP, the ocular-motor model approached significance (Adj. $R^2 = 0.26$, $p = .077$), outperforming the subjective model (Adj. $R^2 = 0.01$). Conversely, subjective drowsiness (i.e., KSS) better predicted reductions in Average Speed (Adj. $R^2 = 0.32$, $p = .010$) and Maximum Speed (Adj. $R^2 = 0.28$, $p = .017$). The ocular-motor model also significantly predicted changes in perceived effort workload (Adj. $R^2 = 0.46$, $p = .012$).

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Benefits to Road Safety

This study provides evidence that a brief pre-drive smartphone smooth pursuit test can identify individuals at elevated risk of drowsy driving impairment, particularly for involuntary driving behaviours (speed variability and swerving) most associated with crash risk. Critically, the ocular-motor model captures impairment that individuals may not consciously report, addressing the well-documented tendency for sleep-deprived individuals to underestimate their own impairment.

Implications for Policy and Practice

A validated, accessible pre-drive impairment tool has broad applicability in both private and occupational contexts. For high-risk populations such as shift workers, heavy vehicle drivers, and healthcare workers with irregular sleep schedules, such a tool could be integrated into fatigue management frameworks as an objective fit-for-duty assessment. Policy development would need to ensure equitable access, noting that disparities in smartphone ownership and digital literacy could disadvantage older or lower-socioeconomic users.

Conclusions

Ocular-motor behaviour, measured using the BrainEye™ smartphone app prior to driving, can predict how sleep-restricted individuals will perform behind the wheel; particularly for involuntary impairment indicators such as speed variability and lane swerving. Subjective drowsiness ratings complement this, predicting intentional speed reduction as a compensatory behaviour. Together, these findings highlight the value of a combined objective and subjective pre-drive assessment approach. This work represents a step towards a scalable, evidence-based approach to empowering drivers to make safer decisions about when to drive, reducing drowsy driving incidents on Australian roads.

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Strategic communications: unlocking practitioner-led road safety change

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Abstract
Safe speed limits are fundamental to reducing harm on our roads, yet implementing speed changes remains one of the most challenging aspects of road safety. Despite strong evidence supporting safer speeds, practitioners frequently lack the practical tools and guidance to engage with and communicate technical decisions to diverse stakeholders and communities. In 2024, an independent review of Transport for NSW's Speed Zoning Standard (TfNSW internal document) revealed a critical gap: practitioners lacked the materials, messaging and tools to confidently engage communities and explain speed zoning decisions. The result was inconsistent approaches across the state and missed opportunities to build public trust and support. This presentation explores how Transport for NSW addressed this challenge by updating the Speed Zoning Standard Engagement and Communications Framework (TfNSW internal document), a change management exercise as much as a communications task, requiring a shift in practice and new approaches for a coordinated statewide response.

Background
Undertaking a speed zone review presents an opportunity to educate communities about safe speeds, why they matter, and how they fit within the broader context of the Safe System and Movement and Place Frameworks.
Well managed engagement and planned communications can influence understanding and adoption of speed zone changes, essential for the broader success of speed management across the state.

The Speed Zoning Standard Communications and Engagement Framework was updated to give practitioners clearer guidance across every stage of a speed zone review, from planning engagement and identifying the right approaches, to identifying stakeholders and the right methods to engage them, to the tools, resources, and approaches needed to engage communities consistently and confidently across NSW.

The result is a statewide communication and engagement framework designed to improve consistency, build practitioner confidence, and strengthen public understanding of speed decisions across NSW.

Conference theme
This presentation aligns with both the Evidence to Action and Collaboration themes. It demonstrates how strategic communications can transform technical evidence into practitioner led communication, and how impactful collaboration, across central and regional teams, is critical to delivering road safety outcomes.

Method
The objectives of this project were to:

- Surface systemic barriers preventing practitioners from communicating effectively
- Build shared understanding of the challenge across central and regional teams
- Develop a coordinated path forward grounded in practitioner experience
- Ensure practitioners were informed, heard, and equipped at every stage of the change process
- Close the engagement loop by reflecting what was heard and confirming next steps

The primary deliverable was a fully updated Communications and Engagement Framework to support implementation of the revised Speed Zoning Standard, designed to improve messaging consistency, reduce resistance, and strengthen public understanding of speed management decisions.

Rather than producing a standard guideline update, a comprehensive, practitioner-led approach was undertaken to address the root causes of miscommunication and community resistance to speed zoning changes.

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The key steps included:

- Framing the change by clearly articulating the rationale, timeline, and implications for practitioners, fronted by senior decision-makers to signal leadership commitment.
- Discovery workshops, held both in-person and online, exploring current practices, identifying pain points, and capturing what was already working well.
- One-on-one conversations providing space for deeper dialogue
- An online playback workshop reflecting what was heard and outlined next steps, reinforcing transparency throughout.
- A final in-person workshop presenting proposed changes, gathered final input, and confirmed alignment before implementation.
- Structured communications keeping practitioners informed at every stage, what had happened, what was changing, what comes next.

This method produced three significant outcomes

- Practitioner-led system redesign - extensive consultation with Transport for NSW teams and frontline practitioners uncovered the real-world challenges driving confusion and pushback, ensuring the framework was grounded in lived experience rather than refined policy language
- From guidelines to a complete engagement system - insights from practitioner consultation were translated into a clear framework supported by ready-to-use tools, templates, messages, and evidence-based narratives, enabling consistent, repeatable practice across NSW rather than relying on individual practitioner judgement
- Reframing engagement as a strategic enabler - by positioning communication as an operational driver of change rather than a compliance step, the framework strengthened the conditions for successful implementation of the Speed Zoning Standard and shifted how practitioners think about their role in speed management

Findings

Several key lessons shaped the approach and strengthened outcomes.

- Building on what already works proved more effective than starting from scratch. Many regional teams had well-established practices delivering real value. Capturing and integrating these into the broader change process accelerated progress and reinforced that good ideas can come from anywhere.
- Listening to lived experience was a turning point. Practitioners who had felt unheard became credible contributors when their experience was acknowledged and acted on quickly. Small, practical adjustments built trust and demonstrated that their insights were shaping real solutions.
- Accepting that consensus is not always possible was equally important. Transparency about decisions, respect for differing views, and a consistent focus on system-wide outcomes allowed the programme to move forward without requiring unanimous agreement — navigating complexity with clarity and empathy rather than avoidance.

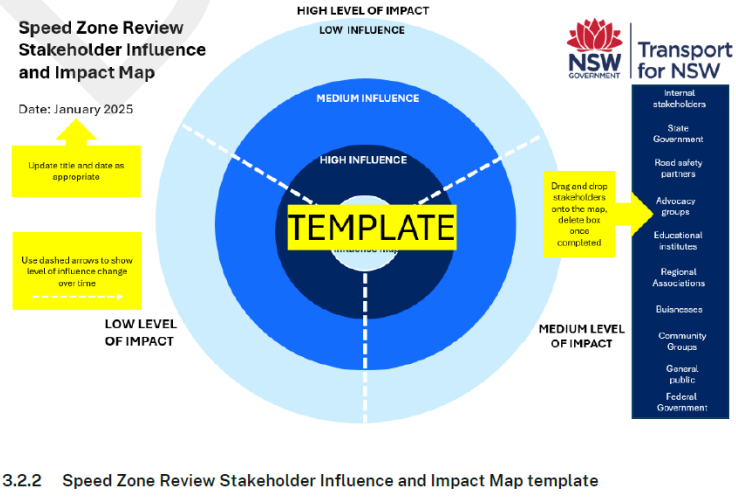

Figure 1. Influence and Impact Map template, Source: Transport for NSW Speed Zoning Standard Communications & Engagement Framework (reproduced with permission)

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Benefits to road safety

When practitioners communicate speed zone decisions clearly and confidently, communities are better informed, elected members are better supported, and the conditions for sustainable speed management are improved. The framework contributes directly to road safety outcomes by creating the conditions under which speed changes can be implemented, adapted to and sustained across the state.

Implications for policy and practice

The findings of this project carry clear implications for how speed management communication is approached at both a policy and practice level.

For policy, the project demonstrates that updating technical standards alone is insufficient. Communications and engagement frameworks must be developed alongside policy changes, not as supplementary guidance, but as integral components of implementation.

For practice, the project reinforces that engagement must be treated as a change management exercise from the outset. Practitioners need more than guidelines, they need structured support, ready-to-use tools, and resources that reflect the real-world complexity of communicating speed zone decisions to diverse stakeholders.

Conclusions

Implementing safer speed limits requires more than technical evidence, it requires the communications and engagement capability to translate that evidence into public understanding and support.

This project demonstrated that by treating the update of Transport for NSW's Speed Zoning Standard Engagement and Communications Framework as a change management exercise, it was possible to address the root causes of practitioner confusion rather than simply refining policy language. The result is a framework grounded in lived practitioner experience, supported by practical tools, and designed to enable consistent, repeatable engagement practice across NSW. The key lesson is clear: strategic communications must be embedded from the outset of any speed management programme, not added at the end.

Future work could usefully evaluate the framework's impact over time, tracking whether practitioner confidence improves, community resistance decreases, and speed zoning changes are adopted more consistently across the state. Sharing this model with other jurisdictions offers an opportunity to strengthen speed management practice beyond NSW and contribute to road safety outcomes across Australia and New Zealand.

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The AiRAP journey to scaling road Safety Star Rating

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Abstract
Approximately 1.2 million people die on our roads globally each year at an unaccounted cost of approximately AUS$5 Trillion/year or the equivalent to 3% to 5% of GDP globally. International Road Assessment Programme (iRAP) has set a target to reduce road deaths and serious injury by 50% by 2030 through Star Rating of roads. iRAP has a Big Hairy Audacious Goal (BHAG) of Star Rating every road in the world. To achieve this, traditional manual methods of Star Rating need to be automated. Over the past 5 years, Anditi has worked closely with iRAP, Austroads and road authorities in the development and implementation of AiRAP (Accelerated and Intelligent Road Assessment Programme). AiRAP uses LiDAR and imagery data in conjunction with other data sources, to automate data attribute and feature extraction techniques for coding and Star Rating the road network. This paper explores the journey over the past 5 years, its challenges, innovations to address these challenges and the progress to date.

Background
As a global community, we have an increasing expectation or 'right' to be able to efficiently and safely travel for work, leisure and connection with our communities. Road safety improvements, having safe roads and the efficiency gains that come from this, are a fundamental component and facilitator of our increasing transit needs and expectations.

In 2025, the highest number of road deaths has been recorded in Australia since 2010 with a 4.3% increase over 2024. iRAP/AusRAP inspired Star Rating of approximately 3 million kms of the 150 million kms of global road network, has assisted in preventing 860,000 Fatalities and Serious Injuries between 2016 and 2025. Much more can be done.

It has taken approximately 10 years to Star Rate 3 million kms of road. To be able to bring the benefits achieved by Star Rating to a greater proportion of our roads and road using community globally, a significantly higher level of automation needs to developed, refined and implemented.

Conference theme
Australia leads the world in the adoption and implementation of AiRAP. This project outlines the actions that have been put in place in improving AiRAP procedures to help shape a brighter future globally. The work undertaken in developing and refining the AiRAP methodology, aligns closely with ARSC2026 theme through the application of evidence driven analytical methods to accelerate improvements in road safety and transit accessibility and efficiency of our road network.

AiRAP Methodology
Traditionally Star Rating of roads has been undertaken manually by accredited coders analysing videos of the road network frame by frame. This requires the manual coder to make up to 3000 decisions per km of road, resulting in a high level of fatigue even over short periods of coding. These decisions are frequently not clear cut and need to take into account the severity and contribution of up to 60 attributes and 300 attribute sub-categories over each 100 m segment of road being coded. This requires expert judgement and a lot of decision making by the manual coder. This manual process can be subjective resulting in inconsistent outcomes between coders and over a period of coding. It is also highly labour intensive. Quality control and auditing of what has been coded requires the same labour intensive effort and induced fatigue.

AiRAP seeks to implement processes to automate coding for Star Rating. Significant development work has been undertaken to achieve this. Anditi has been working on this with iRAP and Austroads over the last 5 years gaining AiRAP accreditation for 34 attributes and accreditation of its RoadViewer Inspection System.
RoadViewer is the only system globally accredited to use mobile LiDAR and 360 degree imagery for coding to enable Star Rating of road networks.

In 2024/2025 Anditi in collaboration with Main Roads Western Australia, used the accredited AiRAP processes it had developed to Star Rate approximately 20,000 kms of the State roads system. This project saw Main Roads and Anditi be jointly awarded iRAP's global 5-star Performer Award for 2025 for AiRAP Global Leadership.

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This project, along with AiRAP projects in Victoria, NSW, Queensland, ACT and South Australia has demonstrated that AiRAP can successfully be utilized for road coding at scale. It has also identified the many challenges that need to be addressed to be able highly automate coding for AiRAP Star Rating. These include:

- Access to data of sufficient accuracy, consistency and coverage to enable automated processes to be utilized without significant monitoring and reprocessing. This requires tools for checking of the entire data set before progressing with automated extraction processes to ensure the data is Fit for Purpose.
- Ability to acquire, handle, process and analyse the massive amounts of geospatial data that are required for AiRAP coding. For Main Roads project, in excess of 60 million attributes had to be identified, extracted, assessed and tracked across multiple computer based workflows to be able to Star Rate 20,000 kms of road network. The size of the Main Roads mobile LiDAR and 360-degree imagery input data increased from approximately 50TB in raw form to over 200TB during the analysis process as each of the required products were generated. The final output from the AiRAP coding was less than 500 MB of spreadsheet data required for uploading into VIDA.
- Developing and refining definitions for each of the 60 attributes to a level of description that can be coded and extracted without further expert or subjective judgement input. To achieve this, Anditi has had numerous discussions and workshops with iRAP, Austroads and road authorities to refine attribute definitions in a way that they can be automatically coded.
- Exposure to a broad range of road networks, conditions and environmental contexts to identify all of the edge and corner cases that might be encountered.
- Recognition that automated processes will not be able to achieve 100% accuracy across the broad spectrum of road networks to be coded and development of advanced processes for quality control and editing at scale. To address this, Anditi developed its RoadCoder software that enables multiple data sources to be viewed simultaneously and edited for quality control. Output from RoadCoder also provides feedback loops for additional training and refinement of AI algorithms used for attribute detection.

Results

Anditi has developed automated methods for checking the quality and consistency of input data, however ongoing development of these tools is needed to improve efficiency. This is also needs to take into account significant variability in input data formats, resolution and scan patterns generated by the wide range of LiDAR scanners and cameras used in generating the input data used.

Methods have been developed for handling, processing and analysing the input data at the ‘industrial scale’ required to assess and code tens of thousands of kms of road network. Further refinement of process efficiency and computational efficiency of algorithms is ongoing.
Anditi has worked closely with iRAP, Austroads and road authorities in reviewing and refining attribute definitions to enable a higher level of automation in attribute extraction and coding for Star Rating. So far refined definitions for 23 attributes have been developed and are currently being utilised. More work is required in regard to a range of attributes including:

- Skid resistance
- Road Condition
- Quality of Curve

Accuracy of the automated attribute extraction processes is high (typically greater than 85%) however more refinement is required for some less frequently coded attributes and for edge and corner cases as they are encountered.

Benefits to Road Safety and Next Steps

AiRAP has already been utilised for a number of road safety coding and Star Rating projects across Australia with the AiRAP techniques used, continuing to be refined and improved. The learnings from these projects will continue to be used to refine AiRAP in terms of accuracy, scalability and application.
iRAP (Rob McInerney AO, Chief of Future Impact) has stated that it is looking to have the majority of roads coded using AiRAP by 2030.

Anditi will continue to work with iRAP, Austroads and road authorities to further develop and implement AiRAP with a view to the AiRAP process being used to Star Rate every road globally.

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Conclusions

Overall the progress to date has demonstrated that AiRAP can be applied at scale and produce results equivalent to or better than human manual coding. Continued utilisation and development of AiRAP process will result in a ongoing improvements and a significant increase in the proportion of the road network that is Star Rated and the frequency that these roads are re-assessed.

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Qualitative perceptions of shifting attitudes towards driving in young adults

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Abstract
Young drivers in inner-regional communities face elevated driving violence risk due to limited transport alternatives, rural road conditions, and local driving norms. This study explored community member's perceptions of driving violence and potential prevention approaches in inner-regional NSW. Qualitative interviews were conducted with young people, parents/carers, and other community stakeholders to explore perceptions of driving violence, barriers and facilitators to safety conversations, and recommendations for prevention. Twenty-nine participants were interviewed. Interviews were transcribed then thematically analysed. Four main themes relating to barriers and facilitators of safe driving emerged, including 1) risk-taking behaviours; 2) rural isolation; 3) parental boundary-setting; and 4) locally relevant prevention messaging. Barriers to reducing driving violence included peer dynamics, thrill-seeking, limited alternative transport, perceived lack of law enforcement presence, and features of the rural driving environment. Participants suggested parental boundary-setting, peer accountability, practical skill development, and locally relevant messaging as potential topics for discussions. The findings provide community perspectives to inform the development of evidence-based local road safety strategies.

Background
Road trauma remains the leading cause of mortality and serious injury among young people within Australia. In 2019, young people aged 15-24 years accounted for 20% of all unintentional on-road motor vehicle injury deaths (Australian Institute of Health and Welfare (AIHW), 2021), despite only making up nearly 13% of all licence holders within Australia (Transport for NSW, 2026). Young drivers (17-25 years) are over-represented in fatal and serious injury crashes, particularly in regional and rural areas (Mason et al., 2022). Additionally, the death rate among young males on Australian roads is four times as higher as that for young females (Australian Institute of Health and Welfare (AIHW), 2021). Risk factors for young driver crashes include sensation-seeking, peer influence, inexperience, fatigue, and reduced access to alternative transport (Knight et al., 2013; Scott-Parker et al., 2015). Rural communities face several of these additional risks, including high-speed roads, extreme climatic conditions, high presence of wildlife, narrow and unsealed roads, and longer post-crash emergency response times (National Road Safety Strategy, 2018; Transport for NSW, 2022). Consequently, drivers on inner-regional and rural roads account for a disproportionate share of fatalities, despite these roads carrying lower traffic volumes (National Road Safety Strategy, 2018).

In Wollondilly, an inner-regional community in the Greater Sydney area, community concern regarding 'driving violence', a term coined by the *Think of the Five – Arrive Alive* organisation to describe dangerous, aggressive, or reckless driving behaviours, highlighted the need for context-specific prevention strategies. While many road safety campaigns adopt broad state or national messaging, evidence suggests that interventions tailored to specific populations and contexts can improve message relevance, credibility, and engagement (Kreuter & Wray, 2003; Pleasant et al., 2020). Therefore, this study explored community perceptions of driving violence and potential prevention approaches, with the aim to guide the future development of a locally responsive driving violence prevention campaign to implement within Wollondilly.

Conference theme
This work directly addresses the ARSC2026 theme From Evidence to Action: Shaping a Brighter Future by gathering local qualitative evidence to inform road safety strategies. Rather than utilising externally designed messaging, this project prioritises lived experience from young people, parents/carers, and community stakeholders to shape local campaign development. The findings provide qualitative evidence to inform future locally relevant interventions designed to influence norms, strengthen parental engagement, and improve safety conversations in inner-regional communities.

Method

A qualitative study design was used to explore in-depth community perceptions of driving violence and opportunities for prevention in inner-regional New South Wales. Participants included young people, parents or carers of young drivers, and community stakeholders with experience or interest in road safety. Participants were recruited through community networks and local organisations, with methods including flyers, email, word of mouth, local community organizational mailing lists and events, and social media. Eligibility criteria included living or working in Wollondilly or residing in surrounding suburbs and having other connections to the Wollondilly community.

One-to-one semi-structured in-person or online interviews (30-45 minutes in duration) with a researcher were conducted to explore perceptions of driving violence, perceived barriers and facilitators to discussing and addressing unsafe driving, and potential approaches for prevention. Interview guides included questions about local driving norms, experiences with young driver behaviour, community influences, and strategies that may support safer driving practices. All interviews were audio-recorded with consent and transcribed verbatim for analysis.

Data were analysed using thematic analysis. Transcripts were reviewed and coded to identify patterns related to perceptions of driving violence and potential prevention strategies. Coding was inductive, with codes generated from the data and grouped into broader categories and themes through an iterative process of comparison and refinement. While interviews explored predefined topic areas, themes were derived from the coded data rather than predetermined categories. The analysis focused on identifying barriers and facilitators to reducing driving violence and improving young driver safety within the local community context.

Findings

Participants described driving violence as shaped by behavioural, structural, and social influences. Four main themes were identified: risk-taking behaviours; rural isolation and limited transport alternatives; parental boundary-setting; and locally relevant prevention messaging**.**

Within the theme of risk-taking behaviours, participants described thrill-seeking, excitement associated with newly acquired independence, and developmental factors as contributors to risky driving. Driving was framed as a coming-of-age milestone, with some young people motivated to demonstrate competence and perceived skill. Peer dynamics were also discussed as influencing behaviour, with social expectations sometimes encouraging risk-taking.

Within the theme of rural isolation, participants emphasised limited public transport, high-speed environments, lower-quality rural road infrastructure, and perceived reductions in law enforcement visibility. Participants described how these factors influenced driving norms and reduced opportunities to intervene when unsafe driving occurred. Limited transport options also reduced young passengers' willingness to challenge unsafe driving due to fear of being stranded or socially excluded.

Within the theme of parental boundary-setting**,** strong parental expectations were widely viewed as protective and positive. Participants identified strategies including limits on passengers and night driving, monitoring tools (e.g., location-sharing applications), parent–teen driving agreements, and restricting vehicle access as useful for influencing young driver behaviours, with consistency in parental rules seen as being particularly important for influencing driving maturity and reinforcing safe behaviour.

Within the theme of locally relevant prevention messaging**,** participants highlighted the importance of concise, relatable messaging that reflected local driving environments. Suggested strategies included practical skill development, peer accountability, real-life scenarios, and tools to support safety conversations between parents and young drivers.

Benefits to road safety

This work contributes to road safety by: (a) Providing locally derived perceptions to inform campaign development; (b) Identifying modifiable protective factors, including parental engagement and peer accountability; (c) Highlighting structural barriers (e.g., transport isolation) that may undermine existing safety messaging; and (d) Supporting the development of parent-focused tools that complement graduated licensing systems. By grounding intervention design in lived experience, this project aims to increase the likelihood of campaign acceptability, cultural fit, and behavioural impact within Wollondilly and other inner-regional areas.

Implications for policy and/or practice

Our findings suggest several implications for road safety policy and future prevention programs, including: (a) Local tailoring of road safety campaigns may improve engagement in inner-regional LGAs; (b) Parent-focused interventions should be integrated alongside youth-directed messaging; (c) Passenger empowerment strategies (e.g., scripts, education on speaking up) may address social barriers to intervention; and (d) Rural transport disadvantage, road infrastructure quality, enforcement visibility, and licensing practices should be considered in policy design, particularly where structural conditions may constrain safe driving choices and reinforce risky driving norms. These recommendations

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align with evidence supporting multi-level approaches to injury prevention that address individual, social, and environmental determinants (Lennon et al., 2022).

Conclusions

Young driver risk in the inner-regional community of Wollondilly and surrounding suburbs is shaped by thrill-seeking, rural isolation, limited transport alternatives, and social norms surrounding independence. Community members identified parental boundary-setting, practical skill development, and locally relevant messaging as key protective strategies. This qualitative evidence provides a foundation for translating community insight into targeted, community-informed road safety action. Future stages of this project will evaluate the feasibility and acceptability of a novel campaign informed by these findings in collaboration with *Think of The Five – Arrive Alive* and partnering community organisations.

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Cross-agency action for safer driving and licensing in Aboriginal communities

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Abstract
The Aboriginal Driver Licensing Interagency (ADLI) was established in 2016 following the 2013 audit *"Improving Legal and Safe Driving among Aboriginal People"* to reduce licensing barriers for Aboriginal people in NSW through targeted programs. Evidence from 2016–2024 shows Aboriginal people in NSW are twice as likely to die on roads as non-Aboriginal people, with over 90% of fatalities and 70% of serious injuries in regional areas. Young adults (17–29) and males are disproportionately affected. Lower licensing rates (51–77% vs. 83%) contribute to these outcomes. In response to this evidence, the ADLI translates research and administrative data into coordinated action through interagency collaboration, locally led programs, and culturally appropriate initiatives. These efforts support safer country roads and align with the NSW Road Safety Plan 2021–2030, demonstrating how evidence-driven action is shaping a brighter future for Aboriginal communities.

Background
The Aboriginal Driver Licensing Interagency (ADLI) was established in 2016, bringing together 14 government agencies from the transport, justice, policing, education and community sectors to coordinate actions that increase access to driver licensing while strengthening Aboriginal community engagement and capacity building.

Evidence shows Aboriginal people have lower driver licensing rates and disproportionately higher levels of licensing offences, transport disadvantage and road trauma. Driver licensing is more than a regulatory requirement; it is a key enabler of road safety, employment, education, health access and social inclusion (Audit Office of New South Wales, 2013; Transport for NSW, 2023). Despite this, only around 54% of eligible Aboriginal people in NSW hold a driver licence, compared with approximately 88% of the non-Aboriginal population (Transport for NSW, 2023).

Unlicensed driving significantly increases crash risk. Between 20–40% of drivers in fatal crashes involving Aboriginal and Torres Strait Islander people are unlicensed, compared with around 5% among other Australians (Bureau of Infrastructure and Transport Research Economics, 2021). Aboriginal people are approximately twice as likely to be killed in road crashes, with over 90% of deaths occurring in regional and remote areas (Bureau of Infrastructure and Transport Research Economics, 2021; Transport for NSW, 2023). Between 2005 and 2023, more than 7,500 Aboriginal people aged 17 and over were hospitalised following road crashes in NSW (Transport for NSW, 2023).

Licence suspensions linked to unpaid fines occur around three times more often among Aboriginal people, highlighting the importance of programs that support fine management and licence reinstatement pathways (Audit Office of New South Wales, 2013). Addressing these structural barriers to licensing and mobility is essential to reducing road trauma and achieving national road safety targets for 2030. The ADLI translates this evidence into eight strategic outcomes guiding coordinated cross-agency action (see Table 1).

Conference theme
Aligning with the conference theme *From Evidence to Action: Shaping a Brighter Future*, the ADLI demonstrates how evidence on licensing barriers and road trauma disparities among Aboriginal people has informed coordinated policy and program responses. Drawing on crash, hospitalisations, licensing and justice system data, the interagency partnership developed with strategic outcomes addressing structural barriers to licensing, safe driving and mobility. These coordinated actions are delivered through partnerships with Aboriginal communities, government agencies and frontline services particularly in regional areas where road trauma risks are highest.

Project description
This study examines the unique approach and outcomes of the ADLI, informed by police crash, hospital, mortality, licensing, and government report data on barriers to driver licensing for Aboriginal people in NSW. Using this evidence and agency expertise, the ADLI developed eight strategic outcomes to address structural licensing barriers and improve safe driving pathways. Member agencies implement initiatives aligned with these outcomes, including licensing education, court diversion, fines management, and community-based driver training in partnership with Aboriginal communities.

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Findings

Implementation of the Aboriginal Driver Licensing Interagency (ADLI) program has strengthened cross-agency coordination and expanded practical licensing support and education for Aboriginal communities across NSW. Licensing access programs are now delivered in multiple regional communities through partnerships with Aboriginal community organisations. Initiatives such as those outlined in Table 1 have enabled coordinated responses to licensing barriers and improved referrals to education, diversion, and licensing programs.

Program implementation also highlights persistent structural barriers, including fines debt, lack of identification, limited access to driver education, and transport disadvantage in regional areas.

Experience from the ADLI highlights several key enablers of effective licensing support initiatives. Sustained collaboration across transport, justice, policing, education and community services enables coordinated referral pathways and responses to barriers such as fines debt and identity documentation. Partnerships with Aboriginal community organisations are critical to delivering culturally safe, locally trusted programs and supporting engagement with licensing pathways.

Table 1 ADLI program of work and key actions

Evidence / Problem Identified	Outcome	Key Actions / Programs
Licence suspensions linked to unpaid fines occur at significantly higher rates among Aboriginal people, restricting legal driving pathways.	Fewer people's access to licences is impacted by fines debt	Amendments to Work and Development Order (WDO) guidelines to improve access; targeting young people to complete WDOs with the Driver Knowledge Test included in WDO activity plans.
Many people enter the fines system due to limited awareness of obligations, financial hardship, or lack of early intervention.	Prevent entry into the fines system through diversion and education	Revenue NSW Community Action Plans; increased debt write-offs through outreach services; First Nations Fines Hotline; mentoring programs supporting young people to complete WDOs.
Aboriginal people have lower driver licence participation and face barriers to testing, driver education, and training.	Increased access to learner licence education, testing and driver training	Driver Licensing Access Program (DLAP); increased Driver Knowledge Test participation; Department of Education driver licensing resources; Life Skills pilot program
Programs that are not culturally appropriate can limit engagement with Aboriginal communities.	Increase the delivery of culturally safe programs	DLAP delivered through partnerships with Aboriginal communities and local service providers; Community Action Plans implemented in key communities
Many people experience barriers obtaining identity documents required for licensing.	Increased access to identity documents	DLAP support assisting participants to obtain identity documentation required to enter the licensing system.
Limited transport options in regional and remote areas restrict access to education, employment, and services.	Reduce transport disadvantage to increase educational, work and social opportunities	Get Licensed, Get Legal, Get Work program; driver licensing pathways linked to employment and training opportunities.
Limited knowledge of road rules, licensing pathways, and safe driving practices contributes to licensing offences and crash risk.	Increased education and communication about legal and safe driving	Department of Education driver licensing resources; NSW Police Youth Command Safe Driver and RYDA presentations in schools; road rules and licensing education delivered through Police Aboriginal Consultative Committee (PACC) meetings.
Courts present an opportunity to divert individuals with licensing offences into support and education programs.	Engage people at court to connect with diversion and education programs	DLAP referrals through Youth Justice supervision; DLAP referrals at court for adult offenders; Driver Licensing Outreach Program assessments and referrals to diversion programs such as Traffic Offenders Intervention Program, WDO and DLAP.

Benefits to road safety

The ADLI program improves road safety by increasing access for Aboriginal people to legal driver licensing, reducing unlicensed driving, and supporting safer driving behaviours. Driver education, training, and culturally informed community programs enhance knowledge and compliance with road rules, while diversion and fines management initiatives provide early intervention for individuals at risk of offences. Collectively, these coordinated actions reduce exposure to high-risk driving, particularly in regional and rural communities, strengthen safe mobility pathways, and support systemic improvements through cross-agency collaboration.

Implications for policy and/or practice

The ADLI demonstrates that cross-agency collaboration and culturally informed programs can effectively address structural barriers to driver licensing, fines management, and safe driving. Operating for over ten years and withstanding changes of government, the ADLI shows the value of sustained, evidence-informed approaches. Policies should prioritise integrated strategies combining licensing support, education, diversion programs, and community engagement. Scaling and sustaining such initiatives support long-term evidence-informed decision-making and contributes to achieving national road safety targets.

Conclusions

The ADLI demonstrates how cross-government collaboration can translate evidence on licensing barriers, fines enforcement, and road trauma disparities into coordinated policy and program responses. By addressing structural barriers to driver licensing—such as fines debt, access to identification, transport disadvantage, and limited driver education—the initiative supports safer and legal driving pathways for Aboriginal people. Importantly, the interagency approach enables government agencies, community organisations, and justice partners to work together to deliver culturally informed, place-based solutions.

The ADLI demonstrates how cross-agency collaboration can translate evidence into practical road safety action and provides a scalable framework for improving driver licensing access and safe mobility for Aboriginal communities.

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DRAFT

Identifying road rules applicable to common midblock crashes involving cyclists

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Abstract
Cyclists are at higher risk of serious injury or death as the result of a crash. In Victoria, 'definitions for classifying accidents' (DCA) allow crashes to be coded by impact type, movement, and road user. However, the DCA are not connected to road rules that set legal expectations for road user actions. In midblock locations without traffic management devices (like traffic signals or signs) expectations set by road rules may contribute to conditions leading to crashes. Analysis of Victorian road crash data identified the five most common DCA sub-codes relating to on-road midblock crashes involving cyclists. *Road Safety Road Rules 2017* (Vic) (VRR) were found to apply road user actions identified in DCA sub-code diagrams. Identifying the road rules involved with common crash types can improve road safety, inform future law reform, and support the development of targeted education campaigns for Victorian road users.

Background
Cyclists, as vulnerable road users, are more likely to suffer serious injury or death as the result of a crash. This susceptibility is only increasing as the number of cyclists in Australia continues to grow (National Walking and Cycling Participation Survey 2021; Fuller et al 2021). Around Australia, laws establish rules instructing the way that road users should behave on roads, shared paths, and footpaths. These rules play an important role in promoting the Safe System approach, which aims to eliminate serious and fatal injuries on road networks. In midblock locations, road users do not benefit from traffic signals, stop or give way signs or lines, that regulate interactions between road users, which are also made more complex by the presence of on-street parking. In midblock locations, laws that establish road user behaviour expectations may play a greater role in keeping road users safe.

While a substantial body of research already exists about crashes involving cyclists, including the factors that may contribute to crash occurrence (Meuleners et al 2020; Rasanen and Summala 1998; Kaplan and Prato 2013), the involvement of road rules is less clear. More specifically, it is not known whether road rules, such as the VRR, contribute to road user actions that lead to crashes due to their lack of clarity, uncertainty or misalignment with current road safety standards.

Conference theme
This project addresses the conference theme *From Evidence to Action: Shaping a Brighter Future* by identifying the road rules involved in the five most reported crash types for cyclists at midblock locations on Victorian roads, providing a basis for legislative reform to better support road safety outcomes.

Project description
This project was completed in two stages. In the first stage, Victorian government crash data was reviewed to identify the five most common DCA sub-codes for the most commonly reported crashes involving cyclists at midblock locations on Victorian roads. In the second stage, the DCA sub-code diagrams were used to identify the key rules from the VRR that applied to the relevant DCA sub-code.

Identify DCA codes for common types of on-road midblock crashes involving cyclists
In Australia, standardised coding systems are used to classify road crashes based on the initial impact and movement of vehicles and pedestrians. The DCA is the system adopted in Victoria, as well as South Australia and Tasmania. Initially DCA classify crashes into 10 codes: 100 pedestrian on foot: 110 vehicles from adjacent directions (intersections); 120 vehicles from opposing directions; 130 vehicles from same direction; 140 manoeuvring; 150 overtaking; 160 on path; 170 off path on straight; 180 off path on curve; 190 passenger and miscellaneous. Each of these codes is further divided into 10 individual 'sub-codes' 0-9 (nine providing a miscellaneous code for each category) (Transport Victoria, undated).

According to road crash data published by Transport Victoria, 185,817 crashes occurred on Victorian roads between 1 January 2012 and 31 December 2024 (Transport Victoria, 2026). The 'Accident' dataset identifies DCA sub-codes for each reported crash through unique 'accident number[s]', together with details of the crash date, time, light conditions,

number of vehicles, injury, fatality, and property. Separately, the 'Vehicle' dataset, the accident numbers are associated with specific vehicle types. Combining these two data sets allows for the identification of cyclist crashes according to DCA sub-codes.

To identify DCA sub-codes that corresponded with on-road midblock crashes involving cyclists, the data was refined several times. The total number of crashes on Victorian roads between 1 January 2012 and 31 December 2024 (n = 185,817) reduced to 96,199 when limited to crashes that occurred 'not at intersection' (road geometry 5). Excluded DCA codes applicable to pedestrians on footpaths (DCA100) and passenger/miscellaneous crashes (DCA190), further reduced the dataset (n = 87,070). To target interactions between road users, single vehicle crashes were then excluded. The resulting dataset (n =52,547) consisted of reported crashes from the following DCA codes: DCA120 crashes from opposing directions; DCA130 crashes from the same direction; DCA140 manoeuvring; DCA160 on path crashes; DCA170 off path on straight crashes. In the final refinement we excluded the two DCA codes with the lowest number of reported crashes (DCA120 and DCA170) resulting 41,920 crashes from DCA codes 130, 140 and 160.

We analysed crash data to identify which specific sub-codes within DCA130, 140, and 160 were most commonly reported for on road midblock crashes involving *cyclists*, by excluding crashes that did not involve the vehicle type 'bicycle'. The resulting figures were divided by the total number of crashes reported for the DCA sub-code to produce a 'crash rate' that was used to identify the five most common crash types for cyclists by DCA code (**Table 1**). The diagram associated with each DCA sub-code diagram appears in **Figure 1**.

Identify road rules that correspond to DCA codes

In Victoria, road rules are set out in the VRR as a statutory instrument authorised by the *Road Safety Act 1986* (Vic) (RSA) to set out general obligations of road users in relation to responsible road use (RSA section 1(ab), section 95, Schedule 2). The VRR contain more than 380 individual rules for bicycle riders and other types of road users (eg drivers of motor vehicles) that are distinguished, for example, by location (e.g. on road, off road, intersection, non-intersection), traffic management devices (e.g. the presence of traffic signals, stop or give way signs or lines, etc).

The description of road locations, traffic management devices, and road users, was compared to the DCA sub-code diagram of road user actions. Comparison of VRR to DCA sub-code diagrams revealed the specific rules applicable to the actions taken by road users in the DCA sub-codes identified as common crash types for midblock crashes involving cyclists on Victorian roads.

Findings

The findings of this project included the five DCA sub-codes identified to be the most common crash type for midblock crashes involving cyclists on Victorian roads, and the specific rules from the VRR applicable to road user actions as shown in DCA sub-code diagrams. As shown in Table 1, cyclists were involved in 17% - 46% of all crashes at on road midblock locations associated with DCA sub-codes 133, 137, 143, 148 and 163. These DCA sub-codes represented the five most common crash types, with crashes associated with other DCA sub-codes in categories 130, 140, and 160 having a crash rate of between 0% and 15%.

Table 1. Common crash type for midblock crashes involving cyclists on Victorian roads by DCA code

DCA code	Total crashes	Crashes involving bicycles	Crash rate
133	1476	253	17%
137	441	136	31%
143	335	83	25%
148	536	246	46%
163	1637	688	42%

DCA sub-codes identified in Table 1 are represented in diagrams produced by Transport Victoria shown in Figure 1. Numbers and letters reflect positioning of road users and other road environment information as defined by Transport Victoria and could be used in analysing road rules applicable to actions in the DCA.

Road user actions depicted in diagrams shown in Figure 1 were compared to the text description of road user behaviours and the road environments contained in the VRR. This allowed for the identification of the road rule that most accurately applied to the behaviour of road users highlighted in the DCA sub-codes in Figure 1. These rules are set out in Table 2:

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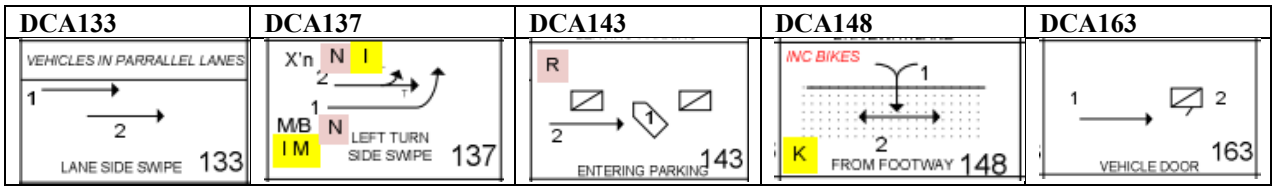

Figure 1. DCA for common midblock crashes involving cyclists (Transport Victoria, undated)

Table 2. VRR applicable to road user actions show in DCA code diagrams for common crash types

DCA code	VRR rule
DCA133	Rule 148(1) Giving way when moving from one marked lane or line of traffic to another marked lane or line of traffic
DCA137	Rule 141(2) No overtaking etc. to the left of a vehicle
DCA143	Rule 148A Giving way when moving within a single marked lane
DCA148	Rule 74 Giving way when entering a road from a road related area or adjacent land
DCA163	Rule 269(3) Opening doors and getting out of a vehicle etc

Table 2 outlines a specific rule from the VRR (or RSA if no VRR rule applicable) that governs road user actions reflected in each DCA sub-code from Table 1. VRR rules were identified as those which regulated the actions of the primary road user identified in the DCA sub-code diagram (road user "1") in Figure 1. Further research may identify that additional 'secondary rules' VRR rules apply to the actions of road user "2" in each DCA sub-code diagram, and further still 'tertiary rules' applicable to other road users in the vicinity of the crash (e.g. drivers of parked vehicles, trams, pedestrians) that may have contributed to conditions in which the crash occurred. VRR rules were identified that accurately reflected the actions of road users "1", or "1" and "2" in DCA sub-codes DCA133, 137, 148, and 163. The finding for DCA sub-codes 143 is notable because the VRR rules about parking do not address this sub-code specifically, leading to the identification of a general 'give way' rule (VRR rule 148A) in its place.

Benefits to road safety

This project benefits road safety by identifying DCA sub-codes for common types of on road midblock crashes involving cyclists on Victorian roads and mapping them against VRR rules that establish legal expectations for road user behaviour at these locations. Examining the road rules in this light can improve the understanding of the role that the law plays in road safety outcomes of road users at mid-block locations.

Implications for policy and/or practice

Identifying road rules applicable to common crash types should inform future policy and law reform and be included in targeted education campaigns for cyclists and motorists throughout Victoria.

Conclusions

This project deepens the understanding of crashes that have been reported in Victoria between 1 January 2012 and 31 December 2024 by identifying rules that establish expected road user behaviours for actions leading up to reported crash types. If rules are found to be unclear, uncertain, or misaligned with current road safety standards, then law reform may have a positive impact on road safety outcomes for cyclists at these locations. Further research is required to identify 'secondary' and 'tertiary' rules relevant to DCA sub-codes and to analyse the identified rules to determine how they correspond to current road design and safety standards.

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DRAFT

Converting community knowledge into structured road safety evidence: MOATS

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Abstract
Maps of Active Transport Severance (MOATS) was developed to understand the locations where people avoid walking, cycling and micromobility because road environments feel unsafe or inaccessible. This project delivered a digital online MOATS tool that standardises community mapping of safer crossings, missing path links and locations where vehicle speeds feel threatening. The tool automates point-based geospatial survey collection and visualisation as heat maps, producing GIS-ready outputs that can be used by practitioners to target investigations and prioritise feasible treatments. Its design was grounded in prior Queensland school-community deployments and literature on community severance, active transport planning, crash under-reporting and human threat detection. The project demonstrated that standardised, low-cost community evidence can be translated into ranked programs of works and embedded within planning, maintenance and renewal workflows. MOATS provides a practical pathway from evidence to action by helping agencies identify latent risk sites before serious injury occurs.

Background
Road agencies are increasingly expected to support walking, cycling and micromobility, yet the dominant systems used to plan, maintain and renew networks were developed primarily around motor vehicle performance. Australian road agencies invest approximately $30 billion annually in road maintenance, renewal and expansion, and 20–40% of annual road expenditure is directed to maintenance and renewal activities (BITRE, 2023). Current performance-based measures for active transport remain relatively narrow, such as measures of pedestrian crossing opportunity at signalised crossings and hazards per kilometre on paths (Austroads, 2018). These metrics are important but do not adequately capture where people avoid routes, crossings or links because they feel unsafe. Active travel severance refers to the extent to which roads, traffic conditions and related transport infrastructure act as physical and psychological barriers that reduce people's ability or willingness to walk, cycle or use micromobility to reach destinations (Anciaes et al., 2016; Mindell et al., 2017). This gap matters because crash data alone does not reveal where networks are failing vulnerable road users. Pedestrian and cyclist crashes are under-reported relative to crashes involving motor vehicle occupants. Equally important, the absence of crashes may indicate that people are already avoiding a location because it feels too dangerous. Research has long shown that roads can act as physical and psychological barriers, affecting not only whether people can cross but whether they are willing to attempt journeys at all.

MOATS responds to this problem by treating users' perceptual responses as meaningful safety evidence. The method asks community members targeted spatial questions about network failure and visualises responses as heat maps of severance. This approach builds on participatory mapping research which has shown that end users can identify the optimal locations for intervention more directly than strategic network planning alone (Milakis & Athanasopoulos, 2014; Chang et al., 2022; Du et al., 2024). It is also consistent with evidence that short local trips and neighbourhood-scale barriers are critical to active transport participation (Goel et al., 2022).

Conference theme
This work directly addresses the ARSC 2026 theme, From Evidence to Action: Shaping a Brighter Future, by demonstrating how road safety evidence can be generated with communities and translated into practicable infrastructure decisions. MOATS shifts community engagement from a late-stage consultation exercise to an early, structured evidence source that helps agencies decide where to act, what treatments to investigate, and how to explain those decisions to communities and funding bodies. The project is also inherently collaborative. It relies on school communities, families, local government practitioners, engineers, planners, advocacy groups and funding partners each contributing different forms of expertise. In this way, MOATS does not simply collect community opinions but additionally creates a shared evidentiary basis for coordinated action.

Project description
The project developed a digital online MOATS tool as a standardised participatory geospatial method for identifying where road networks fail to meet minimum safety and accessibility requirements for people walking, cycling and using micromobility, and for practical use within local government. It integrates three functions that had previously been undertaken in a more manual way: structured community survey deployment, collection of point-based spatial responses, and automatic visualisation of results as heat maps and GIS-ready datasets.

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The survey architecture was deliberately constrained to support consistent interpretation and rapid application. Core spatial questions asked where safer crossings were needed, where better paths were needed, and where vehicle speeds felt too high. Respondents could place multiple markers on online maps, but comments were not attached to individual points. Previous school-community work showed that point-only responses reduce ambiguity, minimise coding effort, and produce outputs that can move quickly from collection to planning. The digital tool standardised these questions, survey logic, map interfaces and export formats so the method and its application can be repeated across communities without redesigning the engagement process each time.

The tool and workflow were informed by several years of Queensland active school travel work, including Sunshine Coast studies involving six school communities, more than 600 parents and thousands of spatial data points. Those earlier deployments consistently showed that respondents can identify specific hotspots for safer crossings and missing links, and that road safety is a stronger barrier to children walking or riding than stranger danger. They also showed that parents regard controlled crossings such as signalised crossings and raised pedestrian crossings as markedly safer than untreated crossings or refuges. These lessons were built into the MOATS tool and the accompanying practitioner workflow.

Once collected, MOATS outputs were used to focus site investigations on clustered locations of concern. The project formalised a prioritisation pathway in which mapped hotspots are reviewed against demand, proximity to destinations, likely crash reduction benefit, feasibility, cost and delivery horizon. The tool supports problem identification and also translation of community-derived evidence into ranked and deliverable work programs.

Findings

The project showed that a digital online MOATS tool can standardise and strengthen the use of community-derived spatial evidence in road safety planning. The project also confirmed why crossings, path continuity and perceived vehicle speed should remain the core MOATS variables. Earlier Queensland school-community studies showed that nearly 80% of respondents agreed that concern about children being hit by a car was a reason they were not allowed to walk or ride, and that providing the crossings and paths requested by communities could substantially increase intended active travel. The completed tool therefore operationalised the issues most closely linked to latent demand, rather than collecting broad but less actionable attitudinal data.

Across completed deployments, MOATS outputs proved useful because they narrowed large and complex networks into a manageable set of locations requiring investigation. Heat maps highlighted recurring hotspots at intersections, uncontrolled crossings, roundabouts, school frontages, side-road crossings and missing path connections (see Figure 1 example of heatmaps used to cluster community needs). These are precisely the types of locations where traditional network planning or crash statistics may fail to convey lived risk. The project confirmed that MOATS data can be used to justify small and medium-scale improvements that are feasible within local capital works programs, while also retaining spatial evidence for larger future projects.

Figure 1. Example MOATS point-based community responses clustered into crossing need hotspots

MOATS value also lies in the collaborative chain it creates. The workflow worked best where school leaders, parents, transport practitioners, engineers and advocacy groups all contributed to problem definition, evidence gathering and the refinement of feasible treatments (see Figure 2 community priorities for signalised and raised pedestrian crossings). This collaborative structure is especially important for active transport because many beneficial treatments are modest in scale but politically or operationally difficult without a clear evidence base.

Benefits to road safety

MOATS improves road safety by making latent risk visible before serious injury occurs. It helps agencies identify locations that people perceive as unsafe and may therefore avoid, including places that do not yet appear in crash datasets. This is particularly valuable for children and other vulnerable users whose travel is highly sensitive to crossing difficulty, perceived speed and network continuity. By providing a transparent evidence base for targeted treatments, MOATS supports more effective prioritisation of road safety investment.

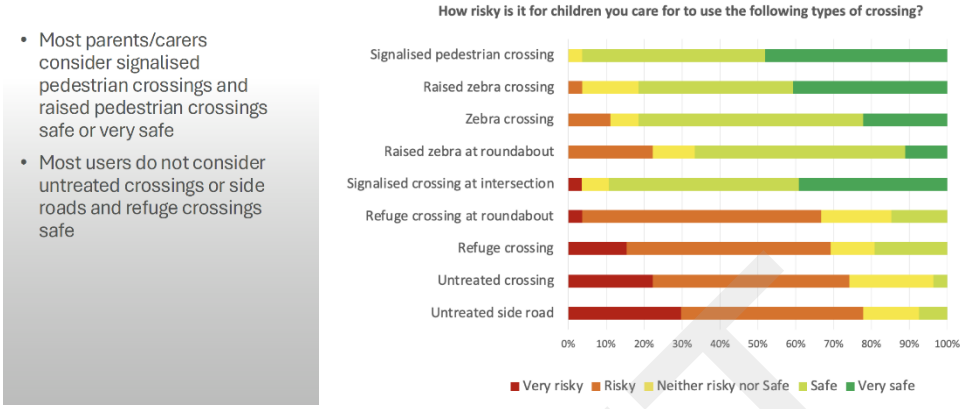

Figure 2. Evidence from MOATS of community priorities for controlled crossings

Implications for policy and/or practice

The principal policy implication is that community-derived spatial evidence should be treated as a legitimate input to planning, maintenance and renewal, not merely as supplementary consultation material. MOATS provides a repeatable method for doing this at relatively low cost. This project demonstrated how all collaborators (ALGA, LGAQ, Safe System Solutions, Sidelines Traffic, Sunshine Coast Council) were able to integrate MOATS outputs into council GIS platforms, active transport planning, safer routes to school programs, maintenance and renewal reviews, and grant development. The project also supports repeating MOATS at regular intervals so agencies can track emerging issues, assess if prior treatments have reduced severance and maintain an accessible record of community-identified needs.

Conclusions

The project demonstrates that MOATS can be operationalised as a digital online tool that converts community knowledge into structured road safety evidence. By standardising the collection and visualisation of spatial responses on crossings, paths and perceived speeds, MOATS helps practitioners move more confidently from evidence to action. Its greatest contribution is not simply that it maps concern, but that it identifies where networks are failing, supports collaboration around feasible responses, and provides a defensible basis for infrastructure decisions that can reduce trauma and increase active travel.

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DRAFT

Raised signalised intersections: review of safety evidence towards guidance

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Abstract
High operating speeds at signalised intersections generate crash impact forces well beyond survivability thresholds for vehicle occupants and Vulnerable Road Users. Raised signalised intersections are an emerging primary Safe System-aligned solution for roads ≥ 50 km/h, addressing a solution gap for urban arterial roads. Raised signalised intersections reduce vehicle speeds at conflict points to below survivable impact thresholds. This abstract consolidates local and international safety evidence on the solution's effectiveness, design and operation, building on earlier Austroads research. Installing raised signalised intersection may reduce casualty crashes by 50%-60%, while retrofitting platforms at already signalised intersections by 24–30%. Australian and New Zealand trials showed that operating intersection entry speeds were generally below 50 km/h – creating Safe System conditions for vehicle occupants. Further trials and evaluations are needed to demonstrate the same for Vulnerable Road Users. The findings will inform updates to Austroads guides, supporting mainstreaming of this Safe System solution.

Background
Conventionally, traffic engineers and transport professionals reserve application of vertical deflection devices exclusively for low-speed, local intersections. Signalisation of intersections has been the main solution for safety and efficiency challenges at arterial roads. While signalised intersections do reduce the likelihood of crashes, they have negligible influence over the severity of the crashes that occur.

A significant proportion of severe casualty crashes occur at arterial signalised intersections. High operating speeds (i.e. 85th percentile speed) generate crash impact forces well beyond the survivability thresholds for occupants of five-star rated vehicles, motorcyclists, cyclists and pedestrians.

Raised signalised intersections on higher speed roads (≥ 50 km/h) offer a Safe System-aligned solution to this problem. They significantly reduce the risk of fatal and serious injury outcomes by moderating vehicle speeds on approaches to and through intersections.

Despite their demonstrated benefits, the uptake of raised signalised intersections in Australasia has been sporadic. This is due in part to perceived operational challenges, inconsistent application, and a lack of clear, practical guidance for practitioners.

This abstract summarises safety aspects of an Austroads project consolidating international and local evidence, clarifying design and operational considerations, and identifying solutions to be considered development of practitioner guidance. The project built on earlier Austroads (2020) review and captures significant new findings and practices.

Conference theme
This presents what the available evidence is saying about an emerging Safe System-aligned solution to intersection related trauma. It concludes by outlining actions being taken to transform this evidence into improved practitioner guidance and design practice. It also points out improved design approaches to make this solution better for the Vulnerable Road Users (VRUs).

Method
The review focussed on raised signalised intersections on roads in ≥ 50 km/h speed environment, such as found on urban arterial roads. Knowledge gaps pertaining to raised signalised intersection safety effectiveness, operation, design, and construction were identified by a stakeholder group of experts from Australian and New Zealand jurisdictions. These gaps were formulated into a series of research questions. A thorough literature review was conducted on each question, using academic research, technical reports, jurisdictional guidelines and international subject matter expert inputs. The full findings were used by the stakeholder group to update Austroads guides. The captured safety evidence is presented and discussed in this abstract.

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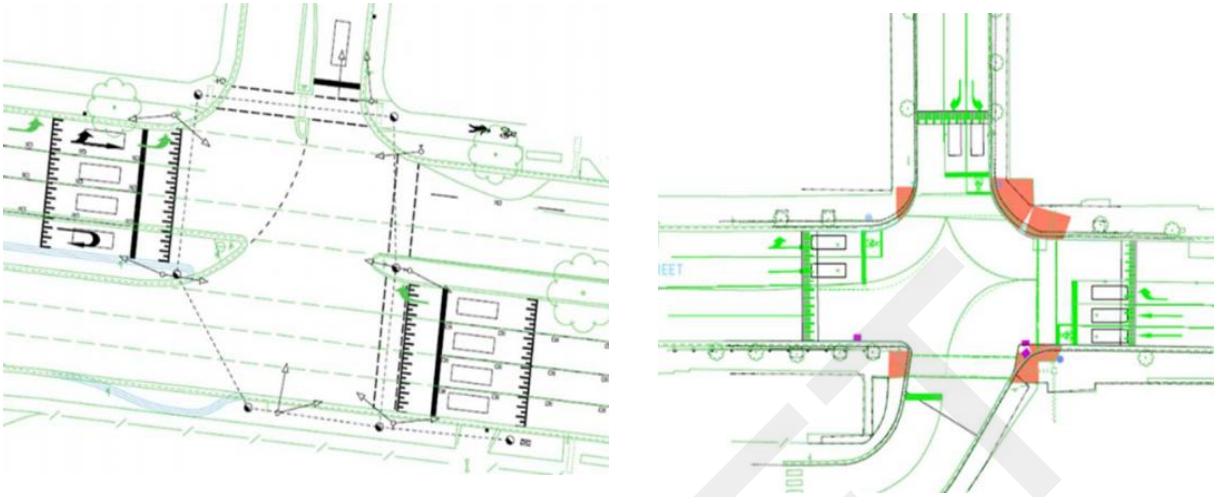
Results

Raised signalised intersections were considered a primary Safe System treatment engineered to reduce vehicle speeds at intersections (Transport for New South Wales, 2025). Their core function was to reduce the maximum comfortable operating speed to align with survivable impact speeds for vehicle side-impact and VRU crash types. Raised Safety Platforms (RSPs) were used to control speeds in two main variants shown in Figure 1: a) RSPs on approach, and b) a fully raised intersection.



a) Approach RSPs b) Raised intersection

Figure 1. Examples of two main variants of a raised signalised intersection.
Sources: a) and b) from Cairney et al. (2021).

Application and design

RSP designs targeted Safe System threshold speeds of ≤ 30 km/h for locations with VRU design priority (e.g. high-activity areas), and ≤ 50 km/h with car occupant design priority and infrequent VRU presence (e.g. major arterials) according to Austroads (2020), and the three available guidelines by Auckland Transport (2024), Department of Transport and Planning (2025) and Transport for New South Wales (2025).

These guidance documents guidelines recommended a hybrid, step-towards Safe System target design speed of 40 km/h to be adopted for those urban arterial roads with 60 km/h speed limits. This was to avoid operating speed reductions of more than 20 km/h per safety platform which could lead to undesirable outcomes, e.g. hard braking, increase in rear-end crashes and potential damage to low floor vehicles, while still improving VRU safety.

There was a strong consensus in the reviewed guidelines that approach RSPs variant (Figure 1a) was more appropriate for divided roads, especially for retrofits, resulting in a lower project footprint and cost. The guidelines agreed that a fully raised intersection design variant (Figure 1 b) was better for smaller sites and at sites with high pedestrian movement or priority.

The three reviewed guidelines agreed that raised signalised intersections should be considered as an exception, or avoided, on routes with significant proportion of heavy vehicles, especially where low-clearance vehicles were present. This was to manage the risk of bottoming-out, road and vehicle damage.

Safe speed effects

Evaluation of several Victorian and New Zealand signalised intersections retrofitted with approach RSPs (Figure 1a) showed that operating intersection entry speeds were generally below 50 km/h. This provided a speed environment close to the Safe System conditions for vehicle occupants, as intended by the designers (Mackie et al., 2019; Cairney et al., 2021; Auckland Transport, 2025).

Cairney et al. (2021) found that operating speeds on intersection departures were higher (44 –54 km/h) than at entries (42 – 49 km/h). Mackie et al. (2019) found even greater departure speed differences, although measured 90-100 m downstream. This suggests a potentially lower safety benefit for VRUs when drivers do not face a raised platform on intersection departure. Still, the sites evaluated by Cairney et al. (2021) showed that progress was made for VRU safety with a 46% reduction in the odds of vehicles exceeding 30 km/h Safe System speed threshold.

These findings also reflect a practice of selecting platform design speeds ≥ 40 km/h at the trialled sites, a compromise on the 30 km/h VRU Safe System speed threshold. This was necessitated by operational efficiency and comfort

considerations (Auckland Transport 2024, Transport for New South Wales, 2025).

Safety effectiveness

The expected crash reduction due to retrofitting an existing signalised intersection with platforms was estimated to be between 24% and 30% (Fortuijn, Carton, and Feddes, 2005; Cairney et al., 2021; Jurewicz, 2024). These were weak or moderately robust sources covering all-casualty and fatal and serious injury crash reduction factors. Earlier Austroads research by Jurewicz et al. (2017) estimated that upgrading a priority-controlled intersections to a raised signalised intersections could result in an all-casualty crash reduction of 50-60%.

Austroads (2020) reported that late braking ahead of the RSPs was observed after installation but diminished with time. Cairney et al. (2021) reported a measured reduction in red-light running following the RSP retrofits, noting that the actual occurrence rate was very rare before and after treatment. Transport for New South Wales (2025) and Mackie et al. (2019) also agreed that the likelihood of red-light running and other traffic conflicts should be reduced by the treatment. There was insufficient evidence to distinguish between safety effects of approach RSPs and fully raised intersections (Figure 1a and 1b variants).

Benefits to road safety

This review brought together and updated disparate threads of safety evidence and practice, so that Austroads guidance could be updated. This will enable and promote mainstreaming of this Safe System design solution for urban intersections.

Implications for policy and/or practice

Consultations with stakeholder group reflected on the available evidence, guidance and practice, noting that these were not always consistent with Safe System principles (Austroads 2024). This was consistent with the solution's emergent status, e.g. knowledge drawn from available retrofitted sites representing their specific goals (e.g. arterial traffic) and contending with multiple design trade-offs.

Stakeholders noted that safety and Safe System alignment of this treatment would be enhanced by RSPs designed for safe speeds for all road users, including VRUs. Further trials were needed to demonstrate such effects.

The findings of the review were used as evidence to support the process of identifying updates to Austroads guides across safety, operation design and construction. This will help jurisdictions to achieve harmonised and consistent Safe System practice.

Both practice and evidence continue to evolve. The need for ongoing implementation, monitoring and a full crash-based evaluation of raised signalised intersections was identified by the stakeholders.

Conclusions

Available safety evidence for raised signalised intersections on ≥ 50 km/h roads suggests they provide Safe System speeds for vehicle occupants and have potential to provide the same for VRUs. Approach RSPs and raised intersection variants can be used across a range of urban environments. The evidence has been used by Austroads stakeholders to work on updated guidance towards mainstreaming this primary Safe System solution.

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DRAFT

In-person study examining drivers' perceptions and confidence using ADAS

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Abstract
This study examined drivers' perceptions towards Advanced Driver Assistance Systems (ADAS) before and after experiencing three ADAS-equipped vehicles on a closed road circuit. Fifty drivers aged 20-81 years (Mage = 45.96, SD = 15.76), 50% female, were recruited to take part in this 2-hour study. Participants experienced six systems, including, lane departure warning, lane keep assist, blind spot monitoring, rear-cross traffic alert, and autonomous emergency braking (front and rear). Compared to pre-drive (baseline), participants reported significantly more favourable attitudes towards ADAS, more belief that those who are important to them would approve of them using ADAS, greater trust, and stronger intentions to use ADAS in the future post-drive. For the six specific ADAS of interest, participants self-reported significantly higher levels of confidence in using all systems post-drive compared to pre-drive. These findings highlight the benefits of providing hands-on experience in improving drivers' perceptions towards ADAS.

Introduction
Advanced Driver Assistance Systems (ADAS) have been proposed to increase driver safety and reduce crash risks (e.g., Cicchino, 2018, 2019). These systems are designed to assist drivers with the driving task, either passively (e.g., via warning alerts) or actively (e.g., by actively steering a vehicle back into the lane or by stopping a vehicle in an emergency). In Australia, most new standard vehicles are equipped with some forms of ADAS (e.g., lane departure warnings, blind spot monitoring), with all new vehicles sold in Australia now required to be fitted with autonomous emergency braking (Australian Government, 2025). However, and despite the effectiveness of these systems, there is a lack of understanding of ADAS, with past research reporting that consumers commonly report learning about these systems via trial and error (e.g., Kaye et al., 2022; Nandavar et al., 2023).

To date, most of the research which has investigated drivers' perceptions of ADAS has focused on online self-report questionnaires and/or focus groups only. This study extends upon previous research to assess a sample of Australian drivers' perceptions towards common ADAS both before and after experiencing these systems in three different passenger vehicles on a closed road circuit. The ADAS of interested included, i) lane departure warning, ii) lane keep assist, iii) blind spot monitoring, iv) rear-cross traffic alert, and v/vi) autonomous emergency braking (front and rear). These systems were selected as they are common new features on vehicles sold in Australia.

The vehicles that participants were asked to drive were purposely sought from three different manufactures and included:

- Mercedes GLE300: A premium SUV, consisting of highly advanced ADAS.
- Ford Everest: One of the top selling vehicles in Australia's Large SUV segment.
- BYD Atto 3: One of the top selling electric vehicle brands in Australia.

The aim of the study was to assess drivers' understanding of ADAS, including common misperceptions and confidence in engaging with these systems. Here, confidence referred to how confident a participant perceived they would be with using each of the six systems. The study was guided by the following research questions:

1. What do Australian drivers know about ADAS?
2. Do participants attitudes, perceptions, and confidence in using ADAS change after experiencing six systems in three different vehicles?
3. What are the common misperceptions towards using ADAS?

Conference theme
Addressing the conference theme *From Evidence to Action: Shaping a Brighter Future*, this research involved a collaboration between Insurance Australia Limited (IAG) and Queensland University of Technology (QUT) (iMOVE project ID # 1-108)(which sought to understand drivers' perceptions towards ADAS after experiencing three different

passenger vehicles on a closed road circuit. The findings from this study will be used to guide the development of educational content.

Method

The study was conducted between January 28th and February 3rd, 2026 at the RACQ Mobility Centre, located in Cornubia, Queensland. Participants (N = 50) were recruited via Farron Research, a market recruitment company. Participants were aged between 20-81 years (Mage = 45.96, SD = 15.76), with 25 identifying as female. All participants were licenced drivers. Participants first completed a baseline questionnaire which examined their demographics, pre-knowledge and current use of ADAS, acceptance of ADAS, familiarity and confidence using ADAS. Next, participants were taken to the road circuit for the driving task, driving the three vehicles for approximately 15 minutes each. A researcher sat in the front passenger seat to direct participants around the circuit and to provide information about each ADAS of interest. Audio recordings captured participants thoughts of each system as they experienced them. After each drive, participants completed a short questionnaire about each specific system in that vehicle, and after all drives, a final questionnaire to measure their perceptions of ADAS post-drives. Participation took 2 hours, and the study received ethics approval by the QUT Human Research Ethics Committee.

Results

Current knowledge and use of ADAS

Most drivers in the sample had some level of understanding of ADAS, with 21 (42%) reporting that the vehicle that they drive most often had ADAS. Of those with ADAS-equipped vehicles, the most used systems included adaptive cruise control and blind spot monitoring. Twelve of the 21 participants reported learning about ADAS via trial and error, and seven participants reported turning off ADAS in their vehicle. Reasonings for turning off systems included concerns about safety, being frustrated or annoyed by the sensitivity of the system and not wanting the system to actively interfere with their driving.

User acceptance and confidence after experiencing ADAS

Six constructs were used to measure user acceptance towards ADAS, including: attitudes, subjective norms, perceived behavioural control (PBC) controllability and capability, trust, and intentions. For this analysis, the focus was on user acceptance of ADAS as a whole, as opposed to each individual system. Paired t-tests showed that when compared to pre-drive (baseline), post-drives participants reported significantly more favourable attitudes towards ADAS, more belief that those who are important to them would approve of them using ADAS, more confidence, greater trust, and stronger intentions to use ADAS in the future (see Table 1).

Table 1. Pre- and post-drive user acceptance ratings of ADAS

Construct	N	Pre-drive *M*(*SD*)	Post-drive M(SD)	*t* [95% CI]	p
Attitudes	48	5.48 (1.27)	6.19 (1.07)	-4.68 [-1.02, -0.41]	<.001
Subjective norms	50	5.15 (1.36)	5.44 (1.55)	-2.06 [-0.57, -0.01]	.045
PBC: Controllability	50	6.10 (1.42)	6.36 (1.06)	-1.76 [-0.56, 0.04]	.085
PBC: Capability	50	6.02 (0.94)	6.60 (0.53)	-4.53 [-0.84, -0.32]	<.001
Trust	50	5.17 (1.29)	5.57 (1.27)	-3.16 [-0.64, -0.14]	.003
Intentions	50	5.42 (1.38)	5.83 (1.37)	-3.24 [-0.66, -0.16]	.002

Note. PBC = perceived behavioural control. Attitudes were measured on a 7-point Sematic Differential Scale using four-word pairs (*unpleasant/pleasant, unfavourable/favourable, unsafe/safe, negative/positive*). All other constructs were measured on a 7-point Likert Scale (1 = *strongly disagree,* 7 = *strongly agree*).

Paired t-tests were then undertaken to assess if there were any changes in self-reported confidence ratings in using each of the six systems participants experienced post-drives. The findings showed that for all six ADAS, participants reported significantly higher confidence ratings with using each ADAS post-drive compared to pre-drive (see Table 2). There were no significant differences in confidence ratings between those who did (n = 21) and did not (n = 29) report regularly driving a vehicle equipped with ADAS.

Common misperceptions about ADAS

Two common misperceptions about ADAS reported by some participants both pre-and post-drives were that drivers have less control over the vehicle when using ADAS and that drivers become over dependent on using these systems. More education about how these systems are designed to assist with the driving task (as opposed to take over control) is required to challenge this first common misperception. For the second misperception identified, there has been limited research to examine if ADAS prevents/reduces drivers' from manually checking their surroundings (e.g., via shoulder checks). More research is also required to examine to what extent (if any) drivers rely solely on ADAS.

Table 2. Pre- and post-drive confidence ratings

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ADAS	N	Pre-drive *M*(*SD*)	Post-drive M(SD)	*t* [95% CI]	p
Lane departure warning	50	5.54 (1.43)	6.30 (1.04)	-4.98 [-1.07, -0.45]	<.001
Lane keep assist	50	5.46 (1.42)	6.22 (1.07)	-4.89 [-1.07, -0.45]	<.001
Blind spot monitoring	50	5.84 (1.31)	6.64 (0.63)	-5.11 [-1.11, -0.49]	<.001
Rear-cross traffic alert	50	4.96 (1.59)	6.28 (0.93)	-6.32 [-1.74, -0.90]	<.001
Autonomous emergency braking (front)	49	5.08 (1.71)	5.80 (1.27)	-3.92 [-1.08, -0.35]	<.001
Autonomous emergency braking (rear)	49	4.82 (1.63)	5.90 (1.23)	-5.31 [-1.49, -0.67]	<.001

Note. For each ADAS, participants were asked, "How confident are you/would you be with using each advanced driver assistance system?" (7-point Likert Scale, 1 = not at all confident, 7 = extremely confident).

Benefits to road safety

This research benefits road safety by providing greater insights into how hands-on experience with ADAS may assist with improving both user acceptance and driver confidence with using these safety systems.

Implications for policy and/or practice

The findings highlight the positive benefits of drivers being shown how specific ADAS work and experiencing these systems in a safe road environment. To date, research has shown that many Australian drivers commonly report learning how to use ADAS via trial and error (e.g., Kaye et al., 2022, Nandavar et al., 2023). This was also evident in the current study, with half of those participants who had an ADAS-equipped vehicle also reporting learning about ADAS via trial and error. Requiring more education about how these systems work at point-of-sale, and gaining more experiencing with using these systems, may also encourage greater use of ADAS.

Conclusions

Overall, this research supports the benefits of hands-on experience in improving drivers' perceptions towards ADAS. Given that ADAS has been proposed to increase road safety by reducing crashes and subsequent injuries and fatalities (e.g., Cicchino, 2018, 2019), educating drivers about the safety benefits of ADAS is vital in ensuring that drivers make full use of the safety benefits of these systems. It is important to acknowledge that this study only comprised of a single item to measure confidence. Therefore, more research is required to assess a driver's level of confidence with using ADAS and whether an increased in confidence may lead to driver complacency.

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DRAFT

Beyond speed management challenges: priorities and opportunities for policy advancement

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Abstract
Speed management has been widely recognised as a promising policy area with significant potential to reduce road trauma, yet its advancement and implementation remain challenging. To help identify directions for improving policy and practice, 37 road safety practitioners who were currently or recently involved in speed management initiatives in Australia completed an online survey. Participants prioritised and ranked key challenges that hinder progress in this policy area and generated ideas for addressing these challenges. The results indicated that the most pressing challenges related to political challenges influenced by public opinion, the need for strong leadership and operational constraints, and limited generalised understanding of speed-related risks. Participants identified that transforming community attitudes, understanding and perceptions around speed, improving governance and accountability, as well as strengthening political leadership and courage would enable progress. This study provides clear directions for Australia to move towards the achievement of road safety targets.

Background
Effective speed management has been highlighted as critical for reducing road trauma (Austroads, 2025), yet policy implementation faces persistent challenges. Research shows that misunderstandings about the risks associated with speeding are common among the population (OECD/ITF, 2018). These misunderstandings shape public opinion and influence political priorities, often associating reduced traffic speeds with transport inefficiency (GRSF, 2023). These dynamics reinforce the status quo and hinder evidence-based decision-making.

Despite these obstacles, speed management remains a high-potential policy field, offering substantial benefits for road safety if these challenges can be addressed (e.g., Job & Brodie, 2022). Understanding practitioners' perspectives on the most significant challenges and potential solutions can become an important source of information for guiding effective policy and practice. Ultimately, this study informs strategic directions for advancing safer, more equitable, and evidence-based road safety management systems.

The aim of this study was to identify the most pressing speed management challenges as identified by road safety practitioners[1] involved in initiatives in Australia, as well as to imagine what a road map towards addressing such challenges would look like. Two main research questions guided the present study:
RQ1: *What are the most important challenges blocking speed management progress?*
RQ2: *How can these challenges potentially be addressed?*

Conference theme
This study supports the conference theme "Shaping a Brighter Future" by identifying priority challenges and potential solutions to advance speed management policy and practice in Australia. The findings rely on the valuable contributions of road safety practitioners involved in speed management initiatives who generously and anonymously participated in the survey, with the ultimate aim of making inroads into reducing road trauma.

Method
An online survey was conducted to examine priority challenges in speed management as perceived by road safety practitioners and to explore potential pathways for addressing them. The survey was administered via Qualtrics and included five sections: demographics; systems-thinking and organisational culture; challenge prioritisation; policy innovation; and perceptions of speed management as a wicked problem. For the present extended abstract, only the challenge prioritisation and policy innovation sections were analysed. The survey was piloted with three experienced practitioners to test clarity and functionality before data collection.

Participants were eligible if they were aged 18 or older, self-identified as road safety practitioners, and had been involved in speed management initiatives in Australia within the previous two years. Broad definitions of "road safety practitioner" and "speed management" were provided to capture a wide range of perspectives. A convenience sampling

[1] A broad understanding of what working in road safety means was adopted and made explicit in the eligibility assessment: "A road safety practitioner is someone whose work interacts with transport in some way" (Green et al., 2024).

strategy was used, recruiting participants through professional networks, email invitations, LinkedIn, Slack, and organisations such as the Australasian College of Road Safety. Data were collected between 23 February and 5 March 2026.

In the prioritisation exercise, participants reviewed fourteen speed management challenges identified in a previous study by the authors[2]. Each challenge was presented with a title and short description, and the order was randomised to minimise bias. Participants first selected the five most important challenges based on their experience and then ranked them from 1 (most important) to 5 (least important).

In the policy innovation section, participants responded open-ended "blue-sky" questions encouraging them to imagine pathways for positive change in speed management with a particular focus on advancing the most important challenge they selected, including enabling conditions and potential steps toward desired outcomes. Participants were not time-limited when completing the survey.

Results

Sample characteristics

A total of 37 respondents completed the survey, who indicated that they were currently or recently involved in speed management initiatives in Australia in at least one of the following domains: education, training and awareness; enforcement and deterrence; infrastructure; vehicles; policy and regulation; advocacy; technology; and research and data. On average, it took participants close to one hour to complete the survey. Most participants were male (73%), 49% were aged 30-44 years old, and they were located across the six Australian States plus the Australian Capital Territory, with Queensland (32%), Victoria (30%) and New South Wales (22%) being the most represented. The sample consisted mostly of practitioners with a career in road safety spanning over a decade, with 49% of them reporting over 20 years of experience. Overall, this study reflects on at least 503 years of experience in the field[3]. A total of 46% of participants were practitioners working for State and Local governments, while the remaining 54% was distributed between people working for the private sector, not for profits and academia.

Priorities for speed management advancement

All of the fourteen challenges presented were selected by at least two participants in this study, suggesting that all challenges were perceived as relevant to some extent based on each participant's experience. To provide an overview of the importance attributed to each challenge within the sample, four measures were selected:

a) **Selection frequency:** Number of times the challenge was selected within the top five out of fourteen challenges.
b) **Selection percentage:** Percentage of participants that selected the challenge within the top five out of fourteen challenges.
c) **Mean rank:** Average rank attributed to the challenge, where 1 is the most and 5 is the least important.
d) **Importance composite score**: Standardised index between 0 and 100, that considers both the number of times this challenge was selected within the top five, as well as the ranking of importance attributed within the top five. The formula applied is:

$$ICS_i = \frac{Selection\ percentage_i \times (6 - Mean\ rank_i)}{Maximum\ selection\ percentage \times (6 - Minimum\ mean\ rank)} \times 100$$

Where i= Challenge i

According to the indicators described above, a ranking of the importance of challenges was calculated (see Table 1, where the 7 most highly ranked challenges are reported for briefness purposes). The challenge titled "public opinion, political barriers and power imbalance" was by far the challenge most often selected as well as the most highly ranked (reason why the ICS for this challenge was equal to 100). This challenge summarises the effects that common misconceptions around speed-related risks impact political priorities that end up prioritising private motorised mobility. The second and third most important challenges identified were titled 'operational and leadership challenges', encompassing the need for strong leadership that fails to provide clear strategic direction reflected in operational challenges such as insufficient resources, and 'challenges in understanding the role of speed', which relates to road users underestimating the risks involved with excessive and inappropriate speeds and behaving accordingly, respectively.

[2] 'Is speed management a 'wicked problem'? A systems-thinking analysis of policy challenges and practical implications', currently under review by a scientific journal.
[3] By considering the lower threshold of each category range within the possible ranges provided for the question "How many years of experience do you have in the field of road safety?", multiplying this number by the number of participants who selected such category, and later on adding all the years of experience combined.

Table 1. Priority challenges identified by participants (n=37)

Name of challenge (in descending order by level of priority)	**Selection Freq.**	**Selection %**	**Mean rank (1-5)**	**Importance composite score (0-100)**
Public opinion, political barriers and power imbalance	29	78.4%	1.55	100.00
Operational and leadership challenges	25	67.6%	2.68	64.34
Challenges in understanding the role of speed	22	59.5%	2.64	57.36
Inertia of the past	19	51.4%	3.68	34.11
Competing mindsets	15	40.5%	3.53	28.68
Lack of systemic and systematic approach	14	37.8%	3.43	27.91
Lack of clear governance	11	29.7%	3.64	20.16

Opportunities for addressing most pressing challenges

A brief summary of responses to the 'blue sky' questions relating to the challenge 'Public opinion, political barriers and power imbalance' is reported here. Most participants suggested the need to focus on: a) Acknowledging the role of the community and working towards building understanding of risks and support of countermeasures. Some strategies to achieve higher public acceptance included awareness campaigns, demonstration trials, and media engagement and enhanced reporting; and b) Strengthening leadership and enhancing political will to address the road safety problem through speed management, which was linked to a positive shift in public opinion but also to enhanced and transparent monitoring and accountability mechanisms. Working for improved governance and accountability mechanisms were also highlighted as important steps.

Benefits to road safety

This study benefits road safety practitioners, decision-makers and researchers alike by setting a clear list of priority areas that experienced practitioners consider need to be tackled in order to make progress in speed management policy and implementation, as well as provides some ideas for addressing these issues based on over 503 combined years of practitioner experience.

Implications for policy and/or practice

The findings of this study suggest that political and community challenges are among the top priorities to advance speed management, according to road safety practitioners. The problem therefore appears to be less technical (i.e., current state of the art of evidence might be not perfect but "good enough") and more political and societal in nature. This calls for a renewed focus on the conditions required to support implementation of speed management countermeasures and provides a basis for reflection on the future strategic direction for speed management.

Conclusions

To progress speed management and unlock its potential for creating societal wellbeing, strategic direction and clear priorities are needed. The present study suggests that road safety practitioners in Australia perceive the main challenges in the speed management field relate to overcoming political and leadership barriers while gaining community support and improving understanding about speed risks.

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DRAFT

Seatbelt positioning during pregnancy: observed and self-reported use among women

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Abstract
Motor vehicle crashes are a leading cause of trauma during pregnancy. Correct seatbelt positioning reduces maternal and fetal injury risk, yet incorrect use is commonly reported. This study examined seatbelt positioning among pregnant women and factors associated with correct use. Pregnant women attending antenatal care at the Royal Hospital for Women (Sydney, Australia) were recruited between February and March 2026. Participants completed a survey on seatbelt behaviours and underwent an observational assessment of seatbelt positioning in a mock vehicle seat. Anthropometric measurements were also collected. Descriptive statistics and comparative analyses examined factors associated with correct seatbelt use. Eighty-eight women participated (mean gestation 32 weeks). All reported 'always' wearing a seatbelt; however, only 44.4% reported correct positioning of both lap and sash belts. Observed correct positioning was higher (67%). Incorrect positioning was significantly associated with higher maternal weight and larger abdominal circumference. Incorrect seatbelt positioning remains common in pregnancy despite universal seatbelt use. Clearer guidance and antenatal education may improve safety for pregnant vehicle occupants.

Background
Motor vehicle crashes (MVC) are a leading cause of trauma during pregnancy, accounting for an estimated 40-75% of trauma incidents among pregnant women (El Kady et al., 2004; Ikossi et al., 2005). Evidence from a large population-based study examining all women who gave birth from 2000 to 2007 in New South Wales (NSW) estimated 3.5 women per 1000 maternities were hospitalised for a MVC during pregnancy (Vivian-Taylor et al., 2012), indicating that crash involvement during pregnancy is not uncommon.

Seatbelts are among the most effective measures for reducing injury severity in motor vehicle crashes and are universally recommended by legislation for pregnant vehicle occupants (National Transport Commission, 2019). Seatbelts function by coupling the occupant to the vehicle, preventing ejection during a MVC and allowing their body to decelerate with the vehicle. In doing so, a seatbelt is designed so that the forces it applies are distributed across the strongest skeletal structures of the occupant (i.e., the clavicles, sternum, and bony pelvis; King, 2018). However, optimal protection requires that the seatbelt is correctly used and positioned. A recent study by Koppel et al. (2025), surveyed approximately 1500 drivers in Australia and found that only 41.4% reported using correct seatbelt positioning.

There have been few studies directly examining the use and quality of seatbelt fit among pregnant women, particularly in Australia. This study aimed to assess quality of seatbelt use among pregnant women in Australia. We also aimed to identify factors associated with the quality of seatbelt use and examine the association between self-reported quality of use and observed quality of use among pregnant women.

Conference theme
This research contributes new evidence on how pregnant women in Australia position and use seatbelts and how observed use corresponds with self-reported use. It also provides new data on factors associated with the observed quality of seatbelt use. This information is essential for developing effective interventions, informing targeted antenatal education strategies and safety messaging for pregnant vehicle occupants in Australia. By providing critical data for translation of findings from previous surveys that reported problems in seatbelt use among pregnant women, this research directly aligns with the conference theme of evidence to action. It also facilitates new ways of doing things in the future, and engagement with maternity clinicians, two other key elements of the conference theme.

Method
This study forms part of an ongoing clinical/research collaborative cross-sectional observational study (2024/ETH00941: Seatbelt Use During Pregnancy) exploring seatbelt use and fit among pregnant women receiving antenatal care at the Royal Hospital for Women in Sydney, which commenced in February 2026. Eligible participants

were women: aged ≥ 18 years with a single or multiple pregnancy, ≥20 weeks gestation, who had travelled in a vehicle since being pregnant and able to communicate in English. Participants were recruited opportunistically during antenatal care by study midwives and invited to participate in study activities. Participation occurred after written informed consent. The parent study aims to recruit 288 participants, stratified across three gestational age groups; 20-27 weeks, 28-35 weeks and ≥36 weeks. The results presented here represent a preliminary analysis of the first 88 eligible participants.

Data collection comprised a survey instrument delivered in two parts, an observational seatbelt fit assessment and optional anthropometric measurements. Part 1 of the Participant Survey was self-administered and captured demographic characteristics, gestational age and self-reported seatbelt use behaviours during pregnancy. The latter included diagrams of different ways seat belts could be positioned, and the survey asked participants to select the diagram that matched how they position the seat belt. Participants were then seated in a mock vehicle seat (Figure 1) and instructed to fasten the seatbelt as they normally would when travelling in their regular vehicle. Seatbelt positioning was assessed for correct fit using a seatbelt observation form. Where incorrect positioning was observed, researchers explained suitable modifications and adjusted the belt to show the correct fit. Following the observations, part 2 of the survey was administered to capture participants' comfort and experiences with seatbelt use during pregnancy, using a 7-point Likert Scale. Lastly, participants were invited to provide optional anthropometric measurements, including height, weight, and abdominal circumference. Descriptive statistics were used to summarise participant characteristics, seatbelt behaviours, fit and experiences. Chi square tests and independent t tests were used to test the significance of differences between groups.

Figure 1. Study seatbelt rig

Findings

A total of 88 pregnant women were included in this preliminary analysis. The mean participant age was 34 years (SD = 5 years), and the mean gestational age was 32 weeks (SD = 6 weeks). Participants were distributed across gestational groups as follows: 20-25 weeks (N=16, 18.4%), 26-30 weeks (N=20, 23%), 31-35 weeks (N=21, 24.1%) and ≥ 36 weeks (N=30, 34.5%). Participants were highly educated and had high-income, with 80.6% holding university qualifications and over half (58.9%) reporting annual household income greater than $150,000.

Self-reported seatbelt use was universal, with all participants indicating they 'always' wear a seatbelt when travelling in a car. Despite 71.1% of participants reporting that they had not changed how they wear their seatbelt during pregnancy, 44.4% indicated they use their seatbelt correctly by indicating correct sash belt and lap belt positioning on the survey diagrams.

Overall, 67% of participants were observed to use their seatbelts correctly while in the rig. Observed incorrect use was slightly more common among women of advanced gestational age, with 34.5% of women ≥36 weeks pregnant observed to incorrectly use their seat belt, compared to 19.6% of those <36 weeks pregnant, however this difference was not statistically significant. In contrast, anthropometric measures of weight and waist circumference were significantly associated with observed incorrect seatbelt use. The mean weight of those correctly using seatbelts was 77.8kg (SD = 11.9) compared to 85.3kg (SD = 15.8, p=0.02) in those who incorrectly used their seatbelt, and the mean waist circumference of those correctly using seatbelts was 104.1cm (SD - 10.4) compared to 111.7cm (SD = 11.6, p=0.005) in those who did not.

Two-thirds of the women (66.3%) agreed (somewhat, agree and strongly agree) with the statement "I am less comfortable in seatbelts than I used to be". However, there was no significant relationship between whether women agreed with this statement and their gestational age, anthropometric measurements or the quality of observed seatbelt use. When asked if they knew how to adjust their vehicle to improve their comfort, one-third (32.6%) reported they did know and approximately one-quarter (24.4%) reported that they had adjusted their vehicle. Women who were ≥36

weeks pregnant were more likely to report adjusting their vehicles than women of earlier gestation groups (p=0.007), but there was no relationship with anthropometric measurements.

Benefits to road safety

These findings highlight important opportunities to improve the protection of pregnant vehicle occupants. Despite universal self-reported seatbelt use, a substantial proportion of pregnant women demonstrated incorrect seatbelt positioning, and this was more common among women with higher weight and larger abdominal circumference. Given that motor vehicle crashes are a leading cause of trauma during pregnancy, and that correct seatbelt use is essential to distributing crash forces across the body's strongest structures, these patterns present a preventable source of risk. The mismatch between self-reported and observed seatbelt fit underscores the need for clearer, more accessible guidance and proactive antenatal education on correct positioning. Strengthening clinician engagement, improving vehicle comfort advice, and tailoring communication for women in later pregnancy or with larger body dimensions could all support safer travel.

Implications for policy and/or practice

By providing new, locally relevant evidence on how pregnant women use seatbelts and the factors associated with incorrect fit, this study offers actionable insights to inform interventions, education, and policy aimed at reducing motor vehicle crash-related harm for pregnant occupants. Policy frameworks could incorporate routine, evidence-based education on correct seatbelt fit and vehicle adjustment to improve comfort into standard antenatal appointments, supported by visual materials, clinician training, and integration into digital maternity resources. The association between incorrect seatbelt positioning and higher weight or larger abdominal circumference suggests that tailored advice may be necessary for women with specific body shapes or in later pregnancy, informing the development of inclusive guidance and targeted messaging. At a systems level, these findings support the need for collaboration among road safety agencies, vehicle manufacturers, and maternity services to improve communication, design user-friendly adjustment information, and ensure that safety messaging reaches women early and often. Enhancing education, strengthening clinical engagement, and embedding correct seatbelt-use guidance into routine maternal care could meaningfully reduce preventable crash-related harm to pregnant women and their unborn babies.

Conclusions

This preliminary study demonstrates that although pregnant women universally report wearing seatbelts, incorrect positioning remains common, creating a preventable source of motor vehicle crash-related risk. There is a notable discrepancy between self-reported and observed correct seatbelt positioning. This incorrect seat belt positioning is more common among women with higher body weight and larger abdominal circumference. Together with the identified discrepancy between self-reported and observed seatbelt positioning, this study highlights the need for clearer guidance, targeted education, and routine support within antenatal care. These findings provide an important foundation for developing effective, evidence-based interventions to improve seatbelt safety for pregnant occupants and reduce injury risk for both women and their unborn babies.

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Investigation of driving-related anxiety, driving performance, and music use

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Abstract
This literature review integrates evidence on current definitions of driving anxiety and how it affects driving performance, how using music affects driving performance, and how music is used to manage different types of anxiety. Generally, we found that driving anxiety may manifest in various ways, including as fear, worry, avoidance, and physiological arousal, which is associated with maladaptive thoughts and unsafe driving behaviours. In non-driving contexts, interventions such as receptive music listening effectively lower anxiety via helping to calm individuals. These findings informed a research protocol to develop a survey to understand driving-related anxiety and investigate its relationship with driving performance and music use, and to develop a tailored music intervention for driving-related anxiety. By managing driving-related anxiety, this research contributes to seeking ways to improve driving performance and road safety.

Introduction
A preliminary review of the existing literature revealed that, although there has been previous research on driving anxiety (Nieuwenhuys & Oudejans, 2017; Stephens et al., 2020; Zinzow & Jeffirs, 2018), the construct of driving anxiety remains poorly defined and inconsistently conceptualised. Additionally, there were no standout studies linking this to driving performance specifically, or music as an intervention to possibly address driving anxiety among non-clinical populations. Therefore, a more comprehensive review was needed.

In response to this identified gap in the literature, we introduce the term *driving-related anxiety* to capture different kinds of anxiety specific to driving. This term encompasses several related constructs, including general trait anxiety, social anxiety, performance anxiety, and test anxiety (in the context of driving tests).

The objective of this study was to conduct a more comprehensive literature review of the inter-related concepts of:

- Driving-related anxiety: to determine how best to define anxiety while driving and what it encompasses as a construct on its own.
- Relationship between driving-related anxiety and performance: to determine if, when, and how any aspects of driving-related anxiety impair driving performance.
- Music interventions: to manage anxiety, that could be applicable to driving-related anxiety.

The purpose of this study was to apply the findings to develop a research protocol for a more in-depth exploration of the associations between driving-related anxiety, driving performance, and the potential mitigating role of music on anxiety.

Conference theme
This literature review revealed that current evidence is insufficient to provide a clear and comprehensive account of driving anxiety or to support music as an effective intervention for driving-related anxiety. In response to this gap, we developed a research protocol to clarify what the general population experiences in terms of driving-related anxiety, how driving-related anxiety is associated with driving performance, and how drivers currently use music while driving. This includes a survey capturing these constructs, with the goal of generating data to help guide the design of a music-based intervention that can meaningfully improve driving performance and at the same time enhance road safety for individuals, especially those experiencing heightened levels of driving-related anxiety. Importantly, the proposed music-based intervention is intended to be accessible and easily integrated into everyday driving, supporting a practical pathway from evidence to action.

Method
The goal of the literature review was to synthesise current findings on different types of anxiety and how they overlap with driving performance. As a part of this review, we also explored the literature on how music affects different aspects of driving. This includes studies investigating both the positive and negative effects of music on driving performance, such as reaction time, attention, and emotion regulation. We also explored studies on how music therapy can be used as an intervention for anxiety outside of driving, such as in clinical or healthcare contexts. This allows us to

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consider whether music therapy or structured listening programmes may potentially help individuals manage driving-related anxiety.
Based on the literature review, we developed a research protocol aimed at investigating driving-related anxiety and evaluating the potential of music-based interventions for driving-related anxiety specifically. This research protocol allows us to understand the degree of driving-related anxiety among a population of participants, to create an accessible intervention that helps improve driving performance, driver well-being, and to enhance road safety outcomes.

Between June 2025 and November 2025, a review of the literature was conducted to examine empirical and theoretical work. Our search targeted peer-reviewed journal articles, conference papers, and books across four databases: Google Scholar, PsycINFO, Scopus, and Web of Science. A combination of keywords was used, including: “drive/driving”, “driving anxiety”, “psychological distress”, “driving fear”, “driving performance”, “driving with music”, “music and anxiety”, “music interventions”, and “music interventions and anxiety”. Reference lists of articles were also screened to help identify additional relevant studies that were not captured in the initial database searches. Studies examining music being used during driving, such as its impact on attention, reaction time, emotional regulation, or stress, were looked at, as were studies evaluating music therapy used for anxiety in other contexts. This literature review process enabled us to identify key gaps in the literature, particularly around the conceptualisation of driving-related anxiety and the limited evidence base for music as a targeted intervention for driving-related anxiety.

Findings

Combining the terms “driver” with “driving anxiety” or “anxiety about driving” or “driver anxiety” yielded 155 results on Scopus and 5 results on PsycINFO. To make the results specific to driving anxiety, we did not include studies that used the generic term “psychological distress”. Out of these results, 5 relevant studies were identified to have included some element of social anxiety or fear of negative evaluation in their definitions or measurements of driving anxiety. Among the remaining results, 12 studies defined or measured driving anxiety to be avoidance-related, 10 classified driving anxiety with driving fear (or similar), and 7 studies looked at driving anxiety as having a specific phobia. 6 studies associated driving anxiety with previous traumatic experiences, while 2 studies linked driving anxiety with test anxiety. Most commonly, 22 studies incorporated the concept of driving anxiety with a measurement of general, trait, or state anxiety, and 6 studies measured driving anxiety using physiological measures. 19 studies linked driving anxiety to specific situations or scenarios that may be anxiety-provoking, and 9 studies measured driving anxiety on a scale from not anxious at all to very anxious. The remaining studies not mentioned here were either not relevant to our search or did not have a detailed definition of driving anxiety.

What these studies have in common is that many of them use a broad, generic definition of driving anxiety without defining or specifying it using specific aspects or elements of anxiety, such as aspects of driving anxiety that may be analogous to those identified in social anxiety. Rather, when driving anxiety is rated on a scale, this leads to ambiguity as individuals are likely to differ in how they conceptualise and interpret driving anxiety. Without a clear conceptual framework or standardised definition of driving anxiety, it is difficult to develop a reliable tool to assess driving-related anxiety, and to develop effective interventions for it.

Overall, driving-related anxiety may manifest in different ways, such as excessive fear, worry, and avoidance during driving tasks such as learning to drive, taking driving tests, or navigating real-world traffic, often accompanied by concentration difficulties, negative cognitions, and physiological arousal (Barnard & Chapman, 2016). Individuals who are highly anxious report higher frequencies of maladaptive thoughts about driving, and greater avoidance compared to those with mild or moderate levels of anxiety. Perceived aggression from other drivers also exacerbates this anxiety, triggering emotional responses like anger that may negatively alter driving behaviours and compromise road safety (Bernstein & Calamia, 2019). Studies that measured driving anxiety via self-report and physiological measures, such as skin conductance and eye movements during simulated driving, show that driving fear may be different from general trait anxiety.

Regarding the impact of music on driving, previous research has primarily examined it as a potential distraction, though positive effects were found, such as a reduction in tension, improved concentration, and better simulated driving performance associated with gentle and joyful music compared to high-arousal music (Li et al., 2025). Moderate-volume, stimulating music can enhance attention and motivation without impairing driver road safety, though effects vary by tempo and personal preference. In terms of music interventions, the literature showed that music interventions have potential to effectively address driving-related anxiety. Interventions such as brief music listening and long-term music therapy have demonstrated efficacy in reducing state and trait anxiety across clinical and non-clinical populations, including before stressors like exams, by lowering heart rate, blood pressure, and cortisol levels, while enhancing mood and ability to concentrate on tasks (de Witte et al., 2025). Other reviews confirm these effects in diverse settings, with receptive music (e.g., simply listening to music with a slow tempo and steady rhythm) showing to be an accessible yet effective intervention.

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Benefits to road safety

Even though the term driving anxiety has not been properly conceptualised and has occasionally been conflated with the term psychological distress, previous studies have indicated that both anxiety or psychological distress can impair driving performance, particularly in areas such as attention and concentration. By establishing a precise conceptual framework of what driving-related anxiety is and developing an accessible and effective music intervention to manage driving-related anxiety, this research aims to enhance driver performance, thereby contributing to improved road safety outcomes.

Implications for policy and/or practice

Establishing a comprehensive definition of driving-related anxiety would help in identifying how driving-related anxiety develops and what it encompasses, understanding its impact on driving performance, and designing evidence-based music interventions to manage driving-related anxiety. If driving-related anxiety is found to be one of the barriers to safe driving, addressing it via interventions should contribute to meaningful improvements in driving performance, and therefore, ultimately, reductions in road crashes.

Conclusions

In conclusion, our research aims to establish what driving-related anxiety is and investigate how it affects driving performance. Additionally, by finding a way to use music to help individuals easily and effectively manage driving-related anxiety, music-based interventions may possibly enhance driving performance (e.g., decision-making, reaction times) and road safety. We are particularly interested in applying this for novice or learner drivers knowing that the licensing process can be a time of heightened driving-related anxiety (Senserrick et al., 2024; Ross et al., 2018) and given the overrepresentation of young novices in crashes. These findings directly informed the development of a research protocol, including the development of a survey to help measure and better define driving-related anxiety, as well as the development of a music-based intervention tailored to drivers experiencing driving-related anxiety that will be tested in a simulator study.

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Driver competency and knowledge over time

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Abstract
Driver knowledge changes over time were investigated along with possibilities for reinforcement, especially as they adapt to evolving road environments and newer road rules, signs and markings. The work involved scanning relevant literature, reviewing key changes to New Zealand (NZ) road rules and traffic control devices (TCDs) over recent decades, a driver knowledge survey about rules, TCDs, and traffic scenarios, and two online workshops with subject matter experts and general road users. There was slight evidence that drivers lose comprehension over time, but very limited evidence on how well drivers adapt to new rules/TCDs. From the survey, the number of years holding a licence was not a strong determinant of knowledge about rules and TCDs, although older rules/TCDs had more correct answers than newer ones. Several potential future intervention options were examined including targeted educational programmes, communication campaigns, sign/marking design, and driver testing.

Background
Providing everyday drivers with high-quality learning development opportunities is important for competent road use and may have implications for safety. This includes not only optimising training and education during initial licensing but also ensuring that knowledge, skills and attitudes are maintained and enhanced as drivers progress through different life stages. To drive safely and responsibly, individuals collectively need cognitive, physical, and attitudinal capabilities. Drivers must know the road code, understand how to operate a vehicle, and be able to make safe decisions in real time based on the environment. They also require sensory capacity and psychomotor skills necessary for safe vehicle control, as well as values, beliefs, and norms that promote safe driving. Ensuring, as far as possible, that drivers possess these capabilities is the primary purpose of driver training, licensing, and enforcement systems.

Knowledge forms the foundation upon which driving skills are built. It is essential for safe and responsible driving, but alone it is insufficient. Drivers must also apply knowledge in real time through practical skill, judgment, and appropriate attitudes. This is supported by the Goals for Driver Education (GDE) Matrix, where knowledge is embedded at each level and serves as the baseline requirement for awareness of risk-increasing factors and self-evaluation, particularly in everyday life and social contexts (Hatakka et al., 2002).

Despite the foundational role of knowledge in the safe and responsible operation of a vehicle, most modern licensing systems place little emphasis on ensuring that drivers maintain adequate knowledge throughout their driving life-course. This involves not only retaining existing knowledge but also acquiring and integrating new information as the road environment, the mix of road users, and vehicle technologies evolve. Consequently, our understanding of driver knowledge over the driving life cycle remains limited. Once initial licences are obtained in NZ, broad-based re-testing of driver knowledge is very rare, resulting in limited population-level data to evaluate the role of knowledge in safe driving. In addition, post-licence education or training interventions tend to focus primarily on hazard and risk perception, and driving skills.

Working together with Mackie Research, ViaStrada were commissioned by the NZ AA Research Foundation to investigate how driver knowledge changes over time and how it could be reinforced as drivers move beyond initial licensing and adapt to evolving road environments and newer road rules, signs and markings. Specifically, the work addressed the following research questions:

1) Do drivers lose knowledge about existing road and traffic rules over time?
2) Do drivers fail to learn about new road rules and traffic control devices (TCDs) and/or fail to adapt their driving behaviours to the changing road environment?
3) What evidence-based knowledge development/maintenance options are available at different life-stages that would address any competence issues identified in research questions one and two?
4) Are any of these options a good fit in the New Zealand (NZ) context?

This presentation summarises the work undertaken, and the key findings and resulting recommendations.

Conference theme - From Evidence to Action: Shaping a Brighter Future
This research formed a preliminary insight into how the current NZ driver licensing and testing system applies over the lifetime of motorists and how this influences their general driving knowledge. Several recommendations from this

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evidence were identified that could be actioned in the future to potentially improve the road safety outcomes of the existing driver licensing and testing system.

Method

The work involved a series of stages:

- A literature scan of readily available NZ and international published and grey literature in the field of driver training and education
- A review of key changes to NZ road rules and traffic control devices over the past few decades
- A driver knowledge survey of the general public asking questions about both historical and newer signs, markings, road rules, and traffic scenarios
- Two separate online workshops with subject matter experts and general road users, to gather feedback on the quality of driver knowledge in NZ and seek feedback on potential driver knowledge development/maintenance options identified

The findings from this work were summarised in a research report (ViaStrada & Mackie Research, 2026) that provided some recommendations for future improvements to the current driver training and licensing system.

Findings

Literature Scan

A targeted scan of relevant literature found that there is limited research on driver knowledge retention and uptake over time. Available studies were mostly conducted in developing countries with less established licensing systems (e.g. Ben-Bassat & Shinar, 2015), while research in the Western World is limited. This may indicate that core safety issues linked to knowledge deficits have already been resolved in Western contexts, or that knowledge retention is considered a relatively lower priority for improving road safety. Few studies explored interventions to improve driver knowledge, with most combining skill, attitude, and knowledge training, making it difficult to isolate the impact of knowledge alone. Studies of driver knowledge retention mostly indicated reduced comprehension among older drivers (e.g. Devlin & McGillivray, 2016). There were limited studies that investigated knowledge alone.

There was very limited literature about experienced drivers not understanding new TCDs or failing to adapt driving behaviours to changing environments making it difficult to draw conclusions. Brief and targeted knowledge interventions can be effective (Ng & Chan 2011). Applying ergonomic principles to traffic sign design so they require less prior knowledge also has potential to enhance comprehension (Ben-Bassat 2019).

Review of Road Rules and TCDs

To better understand the evolution of Rule and TCD changes over the past few decades in NZ, a scan was undertaken of notable changes recorded in official Government transport legislation websites and other notices, as far back as 1988. The review of historical changes to road rules and TCDs found that:

- Several key changes to NZ road rules and TCDs have occurred over recent decades, with public notification ranging from major campaigns to minimal information.
- The evolution of NZs transport system means drivers must navigate newer scenarios by applying basic knowledge to a range of dynamic conditions to ensure road user safety.

Driver Knowledge Survey

A survey of New Zealand drivers was conducted to test their knowledge of rules and other changes. As well as asking 24 questions about certain traffic situations and rules, the survey also asked about several demographic factors, time since last training or testing, and crash history. A total of 535 respondents completed the survey, with the gender, ethnicity and location proportions roughly matching the expected demographics.

Analysis of the survey found that the number of years a licence had been held was not a strong determinant of knowledge about Road Rules and TCDs, with no evidence of decrease in driver knowledge over time. However, older rules/TCDs had more correct answers than newer ones, suggesting a need to regularly remind people of newer rule changes. Questions with greater safety implications also had higher rates of correct answers, suggesting that knowledge which is highly relevant to drivers is reinforced and retained.

There were limited differences in the scores by demographics. However, lower average scores were noted with New Zealanders who had returned after living overseas for some time, and those with converted overseas licences. There was also a possible link between poor survey scores and higher crash risk; however, the sample size was relatively small. A separate analysis of young driver licensing history (ViaStrada 2025) found that a history of unsafe driving behaviours correlated strongly with the frequency of tickets received and crashes having occurred, suggesting that driver attitudes, behaviours, and skills may affect safety performance more than knowledge alone.

Workshops and Options Analysis

Workshops with industry experts and drivers found that:

- Applied knowledge and attitudes were perceived to have more important safety implications than knowledge alone.
- Post-licence driver training initiatives have been shown to have limited safety effects, although some initiatives such as Ride Forever on-road motorcycle training show promise.
- Knowledge interventions should be considered alongside the Safe System and need to be weighed up against other options to improve road safety.

An options analysis, tested in the workshops supported the following driver knowledge development and maintenance initiatives:

- Knowledge campaigns were deemed useful in some contexts but can take a lot of resources to be widely effective. They are however well supported by the public as an area for intervention.
- A knowledge test for overseas visitors, linked to permitted driving, was strongly supported by road user workshop participants. However, it may be difficult to implement due to trade agreements.
- Compulsory knowledge refreshers at re-licensing was well supported by the public. However, the costs to administer and maintain these processes may not justify the potential benefits.

Benefits to road safety

This study hints at potential safety implications of limited provision of knowledge updates throughout a driver's lifetime. More research is possibly needed to confirm this, perhaps in conjunction with trialling the introduction in NZ of several of the recommended options for updating and maintaining driver capabilities.

Implications for policy and/or practice

There is currently a gap in driver training after the initial learner driver training stages, other than professional driver training courses and programmes for older drivers. This research provides an opportunity for the NZ Government and the driver training industry in general to consider introducing further opportunities for knowledge retention or improvement throughout the middle stages of a driving career.

Conclusions

Although most studies showed some evidence of reduced driver comprehension (of which knowledge is a pre-requisite) with age, this research found limited evidence to support knowledge loss over time. While there is limited available literature suggesting experienced drivers have reduced understanding of new TCDs or fail to adapt their driving behaviours to new traffic environments, the survey suggests that newer rules and TCDs are less well understood by NZ drivers. We identified and assessed a range of driver knowledge initiatives, evidence suggests that brief and targeted interventions may be effective for retaining information, but there is not a strong established link to safety outcomes.

We propose the following recommendations to address driver knowledge development/ maintenance:

- Improve understanding of the implication of knowledge deficits in crash risk.
- Ensure that road environments and TCDs are easy to understand and intuitive, so that the impacts of any knowledge deficits are minimised.
- The implementation of knowledge-focused interventions must be weighed carefully against other investments in road safety. However, promising options for the NZ context may include:
    - Targeted knowledge communication campaigns
    - Compulsory knowledge refresher at relicensing
    - Focused refreshers, training, or tests of road rules, TCDs, and difficult driving scenarios for overseas visitors and New Zealand residents who have lived overseas
    - Making initial licence education and testing broader in its focus, beyond rules and TCDs, to focus on good driving habits, attitudes, practices, and self-evaluation in everyday and social contexts.

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Modelling safety and mode shift impacts of speed management

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Abstract
Recent research updated a previous spreadsheet model that estimated changes in safety and mode-share from changes to infrastructure conditions or trip numbers across New Zealand cities. One of the key new findings was the development of a method to adjust safety and mode-shift metrics when speed management measures were introduced. Using data from Elvik's exponential risk model and comparisons of mode-share versus risk in different cities, a method was determined to estimate expected reductions in DSIs and expected increases in active and public transport modes when lower speed limits and traffic calming were applied. The results suggest that, for every 1% (absolute) increase in CQoS/Risk ratio, there is likely to be an absolute increase in cycling mode-share of 0.6-0.8%. Similarly, for every 1% (absolute) decrease in Weighted Risk/km, there is likely to be a proportionate increase in walking mode-share of 0.4-0.6% and 4-6% for public transport (bus/train) modes.

Introduction
Previous research for NZ Transport Agency sought to determine actual and potential safety impacts of achieving mode shift from private motorised vehicles to public transport, active modes and micro-mobility, in conjunction with making changes to the overall volume of travel by all modes (NZTA 2024). It aimed to identify individual and collective safety profiles of different travel modes, and potential safety outcomes for different demographic groups that could arise from mode shift away from private motorised vehicles in New Zealand (NZ).

Following extensive literature review and data analysis, an Excel spreadsheet model was developed to enable mode-shift scenario testing for various situations. The model allowed users to select a combination of city/region and other demographics, and adjust the future mode usage for this combination. Users could also adjust the overall amount of travel (VKT) to reflect any longer-term transport policy changes. From this, the potential road-safety outcomes could be calculated, both in total numbers of deaths and serious injuries (DSIs), and by rate (DSIs per km or hour travelled).

Not all potential factors identified were built into this initial model, so the original research made several recommendations for future enhancement of the model and for strengthening the data underpinning it, including:

- Investigating likely changes in average trip lengths when people change modes
- Investigating typical vehicle-occupancy factors for private/public motor vehicles, to allow for increased person-kilometres travelled (PKT) without increasing VKT to the same extent.
- Identifying and separating out casualty figures for active mode crashes/falls involving and not involving motor vehicles (e.g. slip/trip, hit object, etc).
- Investigating the safety and mode shift effects of introducing lower speed limits to parts of urban areas.
- Updating the model to present a range of possible high and low values (i.e., error margins), to highlight the likely range and uncertainty in some of the estimates.

Subsequent funding by the Transportation Group NZ and their Modelling sub-group allowed the researcher to explore these factors further and develop an updated model. One of the key findings uncovered was the development of a method to adjust safety and mode-shift metrics when speed management measures were introduced. This presentation summarises the work undertaken, summarises the key safety and mode shift effects identified, and presents the final revised model tool.

Conference theme - From Evidence to Action: Shaping a Brighter Future
This work demonstrates how identifying relevant evidence across a selection of safety-related questions led to the development of an actionable mode-shift versus safety model that can be applied by practitioners to improve road safety outcomes in their jurisdictions.

Method
Model update work was undertaken between November 2025 to March 2026. While many of the identified update tasks simply involved extracting and applying data related to trip journey lengths and occupancy rates, a more detailed investigation was required to assess speed management effects on mode shift and safety.
There is good evidence about the safety effects of speed reductions on all travel modes (in terms of reduced DSIs), and also some evidence that lower speeds can encourage greater take-up of active modes.

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Traffic data for each Tier 1 or 2 NZ urban area was obtained from NZTA's MegaMaps database. For each road segment, this included information on road length, traffic volume, road type and road use category, posted speed limit, and mean observed free-flow speed. As the main focus was on urban streets, some road segments were excluded, particularly rural state highways, motorways, and other rural roads. Data was combined to calculate the total lengths of roads with different speed limits and their respective total VKT and average free-flow speed.

Relative risk and speed limits

The Elvik exponential model (Elvik 2013, Elvik *et al.* 2019) was used to find the change in DSIs expected on a road when there is a change in speed.

$$\{Estimated\ DSIs\ After\} = \{Estimated\ DSIs\ Before\} \times \{Relative\ risk\ change\}$$

where:

$$Relative\ risk\ change = e^{(Speed\ After - Speed\ Before) \times exponent}$$

For serious and fatal injuries, the exponent used was 0.06.

Previous research by Elvik *et al.* (2004) showed that, for each 10 km/h of speed limit decrease, an associated ~2.5 km/h decrease is observed in mean operating speeds. Similar findings have been observed in various studies in New Zealand; however, it is possible that greater speed changes could be observed. Based on this, a default 3 km/h estimate of speed change per 10 km/h limit has been assumed. The speed risk model first calculates the initial relative risk of all roads at each speed limit by using the average free speed of the roads compared with a base speed of 20 km/h (which is assumed to have a base risk of 1.00). For example, the 50 km/h streets in Christchurch have an average free-flow speed of 26.0 km/h; therefore, their relative risk (compared with 20km/h) would be $e^{(26-20) \times 0.06} = 1.43$.

By multiplying the relative risk of each speed limit with the total VKT at these speed limits, a 'weighted risk' can be obtained. Summing up the weighted risk across all roads at each speed limit will give the existing total weighted risk if no speed changes are implemented. Users can enter into the spreadsheet model the length of roads they would like to change from an existing speed limit to a new speed limit for these roads, and also whether they want any traffic calming installed. There are checks available to make sure the user does not change more length of road than is available at each speed limit.

To calculate the change in relative risk, there are five steps. Firstly, a new changed free speed of the roads with new speed limits is calculated, based on changes to posted limits and any traffic calming. Next, a weighted average using VKT is used to calculate the new average free speed for each speed limit. The new relative risk for each length of changed road is calculated by using Elvik's relative risk change equation (described above), with the new average free speed for each speed limit used as the 'speed after', and the base (20 km/h) speed used as the 'speed before'. The new relative risks are multiplied by the VKT of the roads at each speed limit of concern and summed together to calculate a new total weighted risk. Finally, the new total weighted risk is divided by the existing total weighted risk to obtain a scaling factor, which is applied to reduce the existing DSIs for all road transport modes.

For example, if the existing total weighted risk for a city's street network is 10,000,000 and the new total weighted risk after lower speed limits are introduced becomes 9,250,000 then the reduced risk factor is 0.925 or a 7.5% reduction in DSIs. This can then be applied to the relative safety of each mode, e.g. if there were previously 100 pedestrian DSIs, that would now become 92.5 DSIs, etc.

Mode shift effects of lower speeds

There has been some research suggesting that reductions in posted speed limits typically results in a greater take-up of active and public transport modes (e.g. Tiwari *et al* 2025, Magkafas *et al* 2025). For cycling, a separate analysis was undertaken relating the changes in weighted risk from speed limit changes (described above) and improved Cycling Quality of Service (CQoS) (described further in NZTA 2024) to potential changes in cycle mode share across NZ.

On the basis that *increased CQoS* and *decreased Weighted Risk* are both likely to increase cycling take-up, a combined ratio of these two factors (i.e. CQoS/Risk ratio) was plotted against the observed mode share percentages across the various main NZ urban centres. A similar attempt was made to estimate likely increases in walking and PT (bus/train) use as well when there are just changes in the speed-adjusted Weighted Risk score (normalised by total road length). From the initial estimates, a high-low range of values was adopted for each.

Results

Figure 1 shows the resulting relationship for cycling mode share relative to changes in CQoS/Risk. While the relationship is slightly weak, the trend provides some indication of increases in cycling when the road speed risk and the cycle-friendliness rating both improve. The results suggest that, for every 1% (absolute) increase in CQoS/Risk ratio, there is likely to be a corresponding (absolute) increase in cycling mode share of 0.6-0.8%.

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Figure 2 shows the relationship between Speed Weighted Risk score per km and the observed Walking Mode share across the various main NZ urban centres. Again, the relationship is somewhat weak, but the trend provides some indication of exponential increases in walking when the distance-adjusted road speed risk reduces. The results suggest that, for every 1% (absolute) decrease in Weighted Risk/km, there is likely to be a corresponding proportionate increase in walking mode share of 0.4-0.6%.

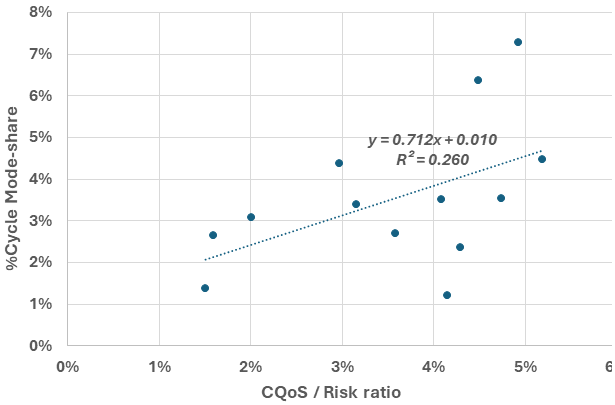

Figure 1. CQoS/Risk ratio vs Cycling mode share

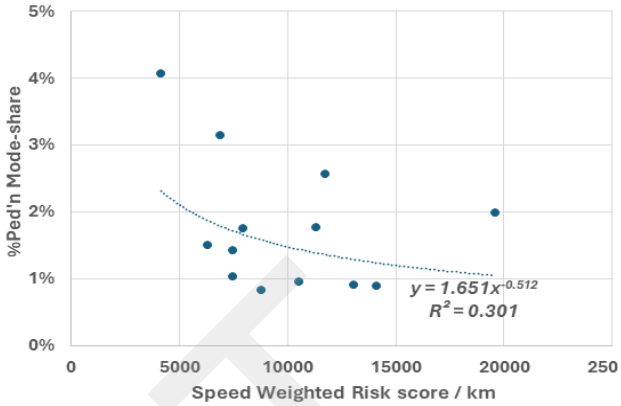

Figure 2. Speed Weighted Risk score vs Pedestrian mode share

We were unable to find a similarly clear relationship between public transport (bus/train) use and the weighted risk score for each urban area. However, other literature reviewed suggests that the increases for public transport modes may be larger than those associated with walking and cycling. For example, switching most urban streets in European cities to 30 km/h limits (which reduces Weighted Risk in major NZ urban areas by ~12-15%) was found to increase public transport by ~60-75% (proportionately). Therefore, we have assumed that, for every 1% (absolute) decrease in Weighted Risk/km, there is likely to be a proportionate increase range of **4-6%** for public transport modes. Some caution with these estimates should be noted, given their European sources.

Benefits to road safety

This work has identified promising trends regarding how speed management measures can positively reduce both road trauma and also increase greater use of sustainable transport modes.

Implications for policy and/or practice

This revised model has the potential to provide considerable flexibility to assess many different mode-shift scenarios, based on existing NZ evidence and indicative trends from associated research. The underlying model relationships could be applied by practitioners to improve road safety outcomes in their jurisdictions.

Conclusions

An updated model has been developed that estimates potential changes to travel mode usage and relative mode safety in several NZ urban centres when various transport policy measures are applied. This latest research has identified several useful relationships between speed management measures and their effect on safety and mode shift. Going forward, further work is likely to be required to verify these relationships by monitoring observed changes to road casualty patterns and travel mode usage with speed-related changes to road infrastructure.

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DRAFT

Fatigued driving risk among new parents

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Abstract
New parents frequently experience sustained sleep disruption, yet their road safety risk remains under-examined. This study investigated sleep patterns, the prevalence of fatigued driving, risk awareness, and fatigue management strategies among Australian parents with at least one child <12 months. An online survey of 1,160 drivers assessed sleep quantity and quality using a modified Pittsburgh Sleep Quality Index, self-reported driving behaviour via the Driver Behaviour Questionnaire, comparative risk perceptions, and behavioural and technological fatigue-mitigation strategies. Participants reported substantial sleep fragmentation, with over 90% reporting driving while fatigued in the previous 30 days. Fatigued driving was reported more frequently than speeding, mobile-phone use, or alcohol/drug impairment, suggesting normalisation and reduced perceived risk. Management strategies relied primarily on short-term behavioural adaptations rather than restorative sleep or in-vehicle technologies. Findings identify new parents as an under-recognised high-risk group and highlight the need for targeted road-safety messaging and clearer communication regarding fatigue-detection technologies.

Introduction
Driver fatigue contributes to an estimated 15–20% of serious road crashes in Australia (Thomas et al., 2021), yet road-safety messaging and policy largely focus on shift workers and long-distance drivers. New parents, defined as adults with at least one child aged under 12 months living with them, represent a large but under-recognised population group exposed to chronic sleep disruption during the first year postpartum due to frequent night-time caregiving demands (Montgomery-Downs et al., 2013; Insana & Montgomery-Downs, 2013). In Australia, approximately 300,000 births are recorded annually (ABS, 2024), meaning a substantial number of adults transition into early parenthood each year and continue to drive regularly for work, healthcare, childcare, and daily activities. Although total time in bed may appear adequate, fragmented sleep reduces alertness, attention, and hazard detection—capabilities critical for safe driving (Kahn et al., 2014). Emerging international evidence indicates that parents of infants report high rates of driving while fatigued and increased attentional errors (Sprajcer et al., 2023; Sánchez-García et al., 2019); however, large-scale Australian data remain limited. Given that new parents frequently undertake essential trips related to healthcare, childcare, and employment, their exposure to fatigue-related driving risk is both common and often unavoidable. Understanding the prevalence, perceptions, and management of fatigued driving in this group is therefore important for informing targeted fatigue-management education campaigns and broader road-safety interventions.

Conference theme
This work translates emerging evidence on sleep disruption and fatigued driving among new parents into clear, actionable road-safety strategies. By identifying new parents as an under-recognised high-risk group and quantifying the prevalence, symptoms, and behavioural patterns associated with fatigue, the study moves beyond awareness to practical intervention points. The findings inform targeted public education campaigns, integration of fatigue guidance into postnatal healthcare, supportive workplace policies, and improved communication about in-vehicle fatigue-detection technologies. In doing so, the research supports evidence-based decision-making across the health, transport, and industry sectors. It demonstrates how empirical data can be applied directly to reduce the risk of preventable crashes. This aligns with the ARSC2026 theme *From Evidence to Action: Shaping a Brighter Future* by converting research insights into realistic, multi-sector solutions that improve everyday driving safety for families.

Method
A cross-sectional online survey was conducted in Australia between April and September 2025. Eligible participants were aged ≥18 years, held a valid driver's licence, drove at least weekly, and had at least one child aged under 12 months living with them. Recruitment occurred via social media and parenting networks. The final analytic sample

comprised 1,160 active drivers. Measures included socio-demographics and driving exposure; sleep quantity and quality using a modified Pittsburgh Sleep Quality Index (Buysse et al., 1989); self-reported aberrant driving behaviours using the Driver Behaviour Questionnaire (Reason et al., 1990); frequency and symptoms of fatigued driving; comparative risk perceptions relative to speeding, mobile-phone use, and alcohol/drug impairment; and behavioural and technological fatigue-mitigation strategies. Descriptive statistics and inferential tests (chi-square, t-tests, and regression where appropriate) were used to examine associations between sleep disruption and driving outcomes. Ethics approval was obtained from a university human research ethics committee.

Results

Participants reported pronounced sleep disruption. Although the mean reported time in bed was 8.8 hours per night, actual sleep averaged 6.0 hours (SD = 1.2), and the modified Pittsburgh Sleep Quality Index indicated generally poor sleep quality (mean global score = 8.5, where >5 reflects clinically meaningful disturbance). Ninety-seven percent reported sleep deprivation due to parenting responsibilities at least often.

Over 90% reported driving while fatigued at least once in the previous 30 days, and nearly two-thirds reported doing so more than once. Common symptoms while driving included poor concentration, tired eyes, and increased blinking (>80%), with around 40% reporting irritability or reduced tolerance toward other drivers. In the previous 12 months, 139 participants reported at least one fatigue-related near-miss, and 12 reported a fatigue-related crash, accounting for approximately one-quarter of all crashes reported in the sample.

Participants who reported driving while fatigued demonstrated significantly higher levels of aberrant driving behaviour across all Driver Behaviour Questionnaire subscales compared with those who reported never driving while fatigued. Specifically, fatigued drivers reported higher aggressive violations ($t(1015) = -2.59$, $p = .01$), general violations ($t(1015) = -4.71$, $p < .001$), lapses ($t(1015) = -6.23$, $p < .001$), and errors ($t(103) = -7.17$, $p < .001$). The largest differences were observed for lapses and errors, indicating that fatigue was particularly associated with attentional failures and unintentional mistakes while driving. Collectively, these findings demonstrate a consistent and statistically significant relationship between self-reported fatigued driving and broader patterns of unsafe driving behaviour. Fatigued driving was reported more frequently than speeding (73% reported ≤10 km/h over the limit), mobile-phone use (45%), or alcohol/drug-impaired driving (<4%).

Fatigue management relied primarily on short-term behavioural strategies: 83% used music or audio stimulation, and 70% engaged in conversation or hands-free calls, whereas only 28% reported napping. Awareness and confidence in in-vehicle fatigue-detection technology were limited: 18% reported that their vehicle was equipped with it, 23% were unsure, and 39% indicated that the technology had no behavioural impact. Collectively, results identify new parents as an under-recognised high-risk group with frequent exposure to fatigue-related driving impairment and limited use of restorative countermeasures.

Benefits to road safety

This work identifies new parents as a large, mobile, and previously under-recognised group at elevated risk of fatigue-related driving impairment. By quantifying the prevalence of sleep disruption, fatigued driving, associated symptoms, and links with aberrant driving behaviours, the study provides evidence that everyday fatigue, not only long-distance or occupational fatigue, contributes meaningfully to unsafe driving. The findings highlight specific behavioural patterns (e.g., reliance on short-term stimulation rather than restorative sleep) and gaps in technology awareness that can be directly targeted to reduce crash and near-miss risk. Recognising early parenthood as a period of heightened fatigue exposure enables more precise risk communication and prevention efforts, with potential to improve safety for both drivers and child passengers.

Implications for policy and/or practice

Results support the development of targeted fatigue-management education campaigns that explicitly address early parenthood and the normalisation of chronic tiredness. Educational messaging should move beyond traditional long-distance fatigue framing to include everyday trips commonly undertaken by new parents, such as commuting, childcare, and healthcare-related travel. Integration of practical fatigue-management guidance into routine postnatal healthcare, parenting support services, and workplace wellbeing programs may provide a scalable prevention pathway aligned with existing family and child safety advice.

Conclusions

New parents experience sustained sleep disruption and report very high rates of driving while fatigued, with significant associations between fatigue and broader unsafe driving behaviours. Fatigue was reported more frequently than other well-established risks, indicating reduced salience and normalisation. Addressing this issue requires coordinated action across road safety, healthcare, workplaces, and vehicle design. Future research should employ longitudinal, objective measures of driving to evaluate targeted interventions and technology adoption, to reduce preventable fatigue-related crashes during early parenthood.

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DRAFT

Effectiveness of modern vehicles in reducing rear-end crashes

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Abstract
Rear-end crashes remain common in Queensland despite increasing uptake of vehicles equipped with adaptive cruise control and crash avoidance technologies. The literature suggests such vehicles should have safety benefits, and further research is required to assess their effects. This study combined administrative data analysis of claims related to rear-end crashes in Queensland and interviews with Queensland drivers. The study found that newer vehicles were less likely to be at-fault in rear-end crashes and more likely to reduce crash severity. The recency of both the hit and at-fault vehicles were found important in reducing the severity of crashes. However, large variations were found, suggesting that other effects are important to take into consideration. The interviews showed that drivers were often unaware of the limitations of the technology and that education may be valuable for increasing the safety benefits of newer vehicles.

Introduction
Despite the introduction of safety assist technologies such as adaptive cruise control and forward collision warning systems in modern vehicles, rear-end crashes remain among the most common types of crashes in Queensland (Swain & Larue, 2024). It is also known that a significant proportion of Queensland drivers drive at unsafe distances to the vehicle in front of them (tailgating), which has been shown to correlate with locations where rear-end crashes are over-represented (blackspots; Rakotonirainy et al., 2017). As the use of adaptive cruise control becomes more prevalent, this raises questions about why rear-end crashes remain at a high proportion of crashes without significant improvements.

While most studies on technology helping the longitudinal control of vehicles have largely focused on their effects on traffic flow, some research has started to look at their effects on safety. Current analyses tend to confirm the promising benefits of such technology in reducing rear-end crashes and their severity, both from autonomous emergency braking (Fildes et al., 2015) and adaptive cruise control (Budd et al., 2020; Cicchino, 2017). However, significant differences can be found depending on whether the analysis is conducted on crash or insurance data, suggesting the need for more comprehensive studies. The increasing penetration of such vehicles on Australian roads also provides opportunities to investigate further benefits, helping in assessing whether the current strategies in place are likely to provide the benefits required to reach the Vision Zero targets.

Importantly, a recent content analysis of vehicle manuals by Nicolls et al. (2026) showed that the implementation of such technology in most vehicles do not follow the Queensland government's recommended safe following distance of two seconds. In addition, many manuals define distance settings using metres at a set speed (e.g., distance 4 leaves a gap of approximately 70 m when the vehicle is travelling at 100 km/hand) and thus may not provide information to drivers in the most effective way. This analysis also showed that the technology is often limited in conditions that are known to be associated with rear-end crashes, such as stop and start traffic conditions. It is therefore vital to understand how these systems are used by drivers and whether additional benefits could be attained if drivers used the technology in their vehicles differently.

We are therefore undertaking a research project combining *(i)* a quantitative study analysing crash data to evaluate the effects of adaptive cruise control/crash avoidance technologies on rear-end crashes in Queensland and *(ii)* a qualitative study based on interviews with Queensland drivers investigating how such technologies are currently used.

Conference theme
This research aligns with the ARSC2026 conference theme *Evidence to Action: What is the evidence telling us?* This study provides an assessment of the current benefits of vehicles with safety assist technologies on rear-end crashes, as well as an understanding of how these technologies are used by drivers.

Method

Crash data analysis
Administrative data were obtained from the Motor Accident Insurance Commission (MAIC) for all claims (N=35,113) related to rear-end crashes between 2014 and 2024. The dataset included the year of manufacture, make and model of vehicles involved in the crashes, as well as whether the vehicle was at-fault or not. Vehicles were classified into four groups, depending on their year of manufacture*: (i) 2002 and older*, representing vehicles with no technology; *(ii) 2003 – 2010*, representing vehicles unlikely to have technology (available only on some luxury vehicles); *(iii) 2011 – 2015*,

representing such technology becoming mainstream on new vehicles; and *(iv) 2016 onwards*, representing vehicles very likely to have forward collision technology.
A quasi-induced exposure method was used to estimate whether these groups of vehicles were more or less likely to be responsible for rear-end crashes. This method has been widely used for rear-end crash analyses, for instance, by Zhao et al. (2019) and Swain and Larue (2024).

To examine the relationship between vehicle age group (treated as an ordered factor) and driver at-fault status, a Bayesian Hierarchical Logistic Regression was used. (Bernoulli family with a logit link function). Then, a Bayesian Hierarchical Cumulative Link Model (Ordinal Logit) was used to assess the effect of both vehicles' age group on the severity of the crash, after controlling for the type of vehicles involved in the crash (proxy for vehicle weight). Three levels of crash severity were considered: Minor (e.g. superficial laceration, contusion), Moderate (e.g. sternum fracture, undisplaced pelvic fracture), Serious or Worse (e.g. displaced long-bone fracture, to total destruction of an organ). To account for unobserved heterogeneity, nested random intercepts for vehicle make and model were included in both models. Data were analysed in R (version 4.4.1) using the brms package (version 2.23.0).

Interviews

Interviews were conducted with Queensland licenced drivers, aged 18 years or older who were using ACC at least once per week. Data collection was driven by convenience and purposive sampling. The study was advertised via paid Meta advertisements and targeted towards the desired sample. In total, 43 drivers (Mage = 43.60 years; ranged from 19 to 70 years; 61% male) participated in one-on-one interviews. Template analysis recognised four themes: 1) knowledge, 2) perceived value, 3) driving variations, and 4) acceptance of adaptive cruise control compared to other technologies.

Results

Crash data analysis

Descriptive statistics of rear-end crash data used in this data analysis are reported in Table1.

Table 1. Rear-end crashes between 2014 and 2024 - At-fault and severity based on vehicle age group

		Vehicle age group			
		2002 and older	**2003 – 2010**	**2011 – 2015**	**2016 onwards**
At fault	Yes	8,870	11,529	9,415	4,370
	No	7,149	12,758	10,366	6,069
Severity	Minor	13,807	22,095	18,015	9,551
	Moderate	1,326	1,578	1,253	635
	Serious or Worse	586	614	513	253

The Bayesian model indicates a significant linear reduction in the probability of being at-fault as vehicles become more recent (b = -0.56, 95% CI [-0.61, -0.51]). A significant quadratic effect (b = -0.10, 95% CI [-0.14, -0.06]) suggests that the benefits of such technology are currently accelerating. Compared to vehicles with no technology, those manufactured since 2016 were 23.3% less likely to be at-fault in rear-end crashes. The model showed high variations between vehicle makes (SD = 2.06) and models (SD =1.24), suggesting that other important factors remain to be considered in the prediction of at-fault status.

In terms of severity, the Bayesian cumulative model demonstrates that crash severity is significantly reduced by newer vehicle technology. Severity was found to primarily reduce linearly as the vehicle's age decreased. Notably, the recency of both the vehicle hit and at-fault vehicles were found to have a similar effect on the severity of the crash, with newer vehicles effectively reducing severity odds by 33% each. When a rear end crash occurs between older vehicles, the probability of the crash being *Moderate* or *Serious and Worse* were 6.8% (95% CI [5.8, 8.0]) and 2.4% (95% CI [2.0, 2.9]) respectively. These probabilities reduce to 2.4% (95% CI [2.0, 2.9]) and 0.8% (95% CI [0.6, 1.1]) respectively if both vehicles are recent.

Interviews

Theme 1 revealed that most participants find adaptive cruise control gap distances too long and select the shortest option, while several issues with the technology were described (e.g., delayed reactions, incorrect speed changes). In addition, drivers were unaware of many adaptive cruise control limitations, yet common limitations (e.g., rain) were recognised. Theme 2 indicated that adaptive cruise control was perceived as safe, useful, and beneficial to control speed and avoid infringements, while trust of the system varied from complete trust to no trust. Theme 3 identified that for some participants, adaptive cruise control reduced their aggressive driving and increased their patience on the road. In addition, many described changes to attention when using adaptive cruise control. Finally, Theme 4 revealed that adaptive cruise control acceptance was common, particularly above other vehicle technologies.

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Benefits to road safety

The preliminary findings from this research show that modern vehicles are likely to be effective at reducing the occurrence of rear-end crashes, as newer vehicles tend to be less at-fault. They are also likely to provide benefits by reducing the severity of crashes, with the recency of both vehicles being as important. However, the benefits might be reduced by large variations due to model and driver characteristics. Interviews with Queensland drivers show that current drivers using such technology are often unaware of their limitations, and there are therefore opportunities to increase their benefits beyond relying on the increased market penetration of these vehicles.

Implications for policy and/or practice

This research has identified how new technology in modern vehicles is likely to be beneficial for reducing rear-end crashes. This is likely due to a combination of passive safety of the vehicle, but also of active safety through a reduction of the speed of the impacts when the crash cannot be avoided entirely. This investigation supports the need for newer vehicles to be deployed on Australian roads, with benefits for both drivers who are likely to be responsible for rear-end crashes (with a reduction of the chance of the crash occurring) and the drivers who are hit during a rear-end crash, as recent vehicles appear to protect passengers better. There are also avenues for extending the benefits of these systems by providing better education to drivers on the limitations and conditions in which such systems should be used.

Conclusions

The current research has found promising effects of recent vehicles for both the occurrence and severity of rear-end crashes. With the increased presence of these vehicles on Australian roads, rear-end crashes will likely decrease in the near future. These vehicles have, however, some limitations that are often unknown to drivers. Therefore, there are opportunities to also improve their benefits by improving how drivers understand and operate such vehicles. The findings of this study are preliminary, and further research is necessary, as large variations were found between makes and models. Some of the effects found may be related to differences in driver risks, as newer vehicles are likely to be driven by older drivers, who are also less risky. Obtaining data on age and gender, as well as details on the technology installed in the vehicles, would be necessary to refine the effects found in this study.

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DRAFT

Evaluating nudges to improve driver behaviour: an on-road trial

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Abstract
Under Queensland's Road Safety Action Plan 2022-24, the Department of Transport and Main Roads (TMR) established a trial of new roadside technology to detect dangerous driving behaviours and provide real time feedback to drivers via messaging displayed on variable message signs (VMSs). The on-road trial of this Behaviour Awareness Monitoring (BAM) comprised two roadside cameras, VMSs, and machine learning to identify motorists engaging (or not) in tailgating and provide targeted messaging via the VMSs relevant to their behaviour to nudge behaviour change. This paper provides the results of the on-road evaluation of BAM conducted at three sites across metropolitan and regional Queensland. Overall, and on balance, the findings provide positive support for BAM in terms of nudging behaviour change. Specifically, BAM motivated change in drivers' tailgating and reinforced safe following distance behaviour as well as, to an extent and while not across all sites, decreases in drivers' average speeds.

Background
Australian road crash statistics reveal increasing trends in the numbers of serious crashes and fatalities in recent years (BITRE, 2021). Raising community awareness is a long-standing component within governments' investment in road safety strategies each year. One method of increasing awareness, variable message signs (VMSs), can play a key role in improving motorists' behaviour. VMSs may display information about traffic-related matters (e.g., crashes, roadwork, road closures), as well as safety communications to change immediate driving behaviour (e.g., speeding) and inform future strategic driving choices (e.g., drink driving, fatigued driving). VMSs include permanent overhead gantry-style infrastructure through to temporary, roadside verge/median strip trailers. Studies have demonstrated the effectiveness of roadside signage including portable VMSs in reducing dangerous behaviours (Glendon & Lewis, 2022).

The TMR-led trial began with the development and controlled-environment testing of a roadside technology system that uses cameras and machine learning to detects a driver's engagement (or not) in dangerous driving behaviours, and a VMS to provide targeted messaging in real-time. Known as the Behaviour Awareness Monitoring (BAM) initiative, the system aims to change the behaviours (or, conversely, reinforce safe driving behaviours) using the conceptual underpinning of Nudge theory. Nudge theory posits that governments should nudge individuals to make better decisions rather than relying solely on efforts to force them to comply through enforcement and, in doing so, respect their freedom of choice (Egan, 2017; Thaler & Sunstein, 2009;). Thus, in attempts to nudge safer behavioural choices, targeted messaging for display on VMSs was purpose-devised and tested prior to implementation within the BAM trial. For the on-road trial and evaluation of the effectiveness of BAM as a means to nudge behaviour change, the behaviour of focus detected by the technology and for which messaging was subsequently targeted was tailgating.

Conference theme
This work comprises a robust evaluation conducted on-road and which supports a new and novel way to engage community through targeted messages that educate and nudge drivers' positive behaviour change rather than relying solely on enforcement. The project highlights the power of impactful collaboration between government, academia, and industry to deliver optimal and innovative solutions for road safety now and into the future.

Method
Three sites across metropolitan and regional Queensland were chosen based on adherence with specific site requirements (e.g., positioning of cameras and VMS on a straight section of single-lane State-controlled road with a set speed limit). A baseline period was conducted whereby the cameras were switched on and driver behaviour was monitored but the VMS was not activated. This phase enabled testing of the system and preliminary monitoring of driver behaviour at these sites. The on-road trial used a quasi-experimental pre-post design across the three test sites. At each site, two fixed cameras were installed 200-400 metres apart with a VMS positioned between them. In the intervention phase of the trial, the VMS was switched on and displayed either a warning message to drivers who were following too closely (i.e., travelling with headways between 0.3-2 seconds: the 'red' category message) or a positive message to those maintaining a safe gap (i.e., travelling with headways of over 2 to 5 seconds: the 'green' category message). Vehicles travelling below 40 km/h, with no recorded interval, or with headway intervals below 0.3 seconds or more than 5 seconds did not receive a message (i.e., were classified as the 'N/A' category). For the purposes of the

evaluation, each vehicle detected at Camera 1 was to be re-identified at Camera 2 to assess changes in drivers' following distances and speed.

Data collection for the intervention phase of the on-road trial was completed in November 2025, with at least two months and up to three months of driving data collected at each site for the evaluation. Across the three trial sites, the system detected over 2.54 million vehicles at Camera 1 and matched 1.69 million of these vehicles at Camera 2. Matching rates depended on the system's capacity to detect vehicles and may have also been affected by site-specific factors, such as the higher posted speed limit at Site 3 or the merging lane before Camera 2 at Site 2. Of the total number of vehicles that were matched at Camera 1 and 2 across the three sites, the VMS displayed over 459,000 'green' or 'red' messages. Rates of successful message delivery were broadly consistent across the sites, with minimal system-related errors recorded (<0.1% of all events). Specifically, of the total number of messages delivered during the trial:

1. 217,107 vehicles (47.3%) received 'red' messages indicating they were following "Too Close" (i.e., travelling 0.3 to 2 seconds behind the vehicle in front).
2. 242,003 vehicles (52.7%) received 'green' messages indicating they were following with a "Safe Gap" (i.e., travelling 2 to 5 seconds behind the vehicle in front).

Figure 1. BAM in action at one of the field trial sites, displaying a 'red' message for tailgating behaviour

Results

The data analysis for this evaluation focused on examining how BAM influenced drivers' following distances and speeds across the three trial sites during the intervention phase. Following distances were analysed using descriptive statistics and Chi-square tests to assess changes in the proportions of drivers tailgating or maintaining safe distances at each camera across the sites. Speed analyses involved descriptive summaries and mixed-design ANOVAs to evaluate changes in average speeds across the sites and following-distance categories. These analyses assessed whether drivers' initial following distances influenced changes in speeds.

Evaluating behaviour change regarding drivers' following distances

Drivers who received a 'red' message at Camera 1

Regarding changing behaviour among drivers who were following too closely, Table 1 shows the percentages of behaviour change at Camera 2 for drivers who had received a 'red' message for following too closely at Camera 1.

Table 1. Behaviour change at Camera 2 for drivers who received a 'red' too close message

Following distance at CAM2	Site 1	Site 2	Site 3	Weighted Average	Aggregate positive behaviour change
Green safe gap (2-5 second gap)	15.9%	22.7%	25.4%	20.1%	31.4%
No message (> 5 second gap or <40 km/h speed)	14.3%	13.0%	2.3%	11.3%	
Red too close (>0/3-<2 second gap)	69.8%	64.3%	72.3%	68.6%	
Total	100.0%	100%	100%	100%	

As shown via the green shading in Table 1, a change from a 'red' message at Camera 1 to classification at Camera 2 of either a 'green' safe gap or a 'N/A' no message category both represent positive behaviour change as it is indicative of a driver having either increased their following distance or having decreased their speed from Camera 1 to Camera 2. Overall, an average of 31.4% of drivers (n = 68,171 drivers) across all three sites who were tailgating at Camera 1 (and who received the 'red' message) positively changed their behaviour by either increasing their following distance or slowing down by Camera 2. While the findings demonstrate positive behaviour change overall, a notable proportion of drivers who received a 'red' message continued tailgating at Camera 2, suggesting that behavioural nudges may not be equally effective across all drivers. This highlights the challenges associated with changing driver behaviour, as driving habits are often reinforced by traffic conditions, routine behaviours, contextual influences, and social norms.

Drivers who received a 'green' message at Camera 1

Regarding reinforcing behaviour among drivers travelling at a safe distance, Table 2 shows percentages of behaviour change at Camera 2 for drivers who received a 'green' safe gap message for a safe following distance at Camera 1. After receiving a 'green' message, most drivers (84.3%) maintained their positive driving behaviour (driving with following distances of greater than 2 seconds), suggesting the system is also positively influencing behaviour through reinforcing the safe behaviour of those already travelling at safe following distances and speeds through the trial sites.

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Table 2. Behaviour change at Camera 2 for drivers who received a 'green' safe gap message

Following distance at CAM2	Site 1	Site 2	Site 3	Weighted Average	Aggregate positive behaviour
Green safe gap (2-5 second gap)	63.7%	65.1%	71.3%	66.0%	84.3%
No message (> 5 second gap or <40 km/h speed)	18.7%	21.5%	13.3%	18.3%	
Red too close (>0.3- <2 second gap)	17.6%	13.4%	15.4%	15.7%	
Total	100.0%	100%	100%	100%	

Evaluating behaviour change regarding drivers' speeds

As Table 3 shows, some reductions in drivers' average speed between the two cameras were achieved at both Sites 1 and 2; however, at Site 3, there was an increase in drivers' average speed. The weighted average difference in drivers' speed (weighted to account for the difference in number of matched vehicles at each site) based on the aggregated data from the trial's intervention phase indicates a speed reduction of -0.71km/h.

Table 3. Average difference in vehicle speeds at each camera and across the three trial sites

	Site 1	Site 2	Site 3	Weighted Average difference in speed
Speed at Camera 1	54.44km/h	53.88km/h	67.62km/h	
Speed at Camera 2	53.36km/h	51.35km/h	70.03km/h	
Difference in speed	-1.08km/h	-2.53km/h	+2.41km/h	-0.71 km/h

While there were reductions in drivers' speed between Camera 1 and Camera 2 evident at both Sites 1 and 2, it is acknowledged that other factors, beyond BAM, may have also contributed to these reductions such as vehicles slowing for the traffic lights ahead or because vehicles in front may have corrected, and thus reduced, their following distance after receiving the 'red' message which subsequently meant other drivers had to adjust their behaviour. However, Site 3 was the most regional site of the three and spanned the greatest distance between Camera 1 and 2. Here, drivers likely had greater opportunity to choose their driving speed. This suggestion is consistent with a behavioural tendency that has been witnessed in the broader speed camera enforcement literature where drivers may reduce speeds for a relatively short period immediately following a speed enforcement camera (which we liken in the BAM trial to their sighting of the first camera) but then they may increase their speed passed the camera.

Benefits to road safety

This evaluation shows objectively measured, positive driver behaviour change resulting from an innovative solution, BAM. BAM combines advancing technology and a robust conceptual underpinning based on nudge theory. BAM educates and engages drivers to better understand safe and unsafe behaviours, with significant benefits for road safety.

Implications for policy and/or practice

The study exemplifies the power of collaboration between government, academic, and industry partners, working together to implement robust methods to support evidenced-based decision making to enhance the safety of roads for all. The results highlight several practical considerations for future implementation that may impact system performance and driver responses, including considering site-specific characteristics, examining the longer-term behavioural effects of BAM messaging, evaluating alternative message display designs, and exploring strategies for improving effectiveness among drivers who remain unresponsive to feedback. In addition, continued refinement of the robustness and reliability of the system and the monitoring and evaluation processes will also help maximise the effectiveness of BAM as part of broader road safety programs.

Conclusions

Overall and on balance, the on-road trial evaluation findings provide positive support for BAM in terms of it nudging behaviour change through helping drivers understand what constituted a safe following distance or a distance that was too close. Specifically, BAM functioned to change drivers' tailgating behaviour and reinforce safe following distance behaviour as well as, to an extent and while not across all sites, decrease drivers' average speeds.

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DRAFT

Evaluating Re:act road safety campaigns for young people

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Presenter: Andrew Hardwick

Abstract
The Re:act Behaviour Change program is a unique collaboration between industry, government and higher education institutions where students produce peer-to-peer road safety campaigns in efforts to positively influence the beliefs and behaviours of young adults. Re:act is the only tertiary mandatory road safety program running in Australia. This study comprised impact evaluations of the 2024 and 2025 Re:act campaigns which addressed driver or pedestrian mobile phone distraction (2024) and seatbelt use (2025). The evaluations were underpinned by the Step approach to Message Design and Testing (SatMDT) framework. Overall, the results support the positive effects of the campaigns on relatively large samples of Australian young people. While results were not compared statistically between the two evaluations (given different behaviours), the results were especially positive for mobile phone distraction campaigns relative to the seatbelt campaigns; however, this likely reflects relatively high seatbelt compliance within the nation.

Background
With young people aged 17-25 years over-represented in road trauma, behaviour change interventions offer an important strategy in efforts to improve road safety attitudes and behaviours. Moreover, evidence supports the benefits of peer-to-peer approaches, where young people design content for other young people (Buckley & Watson, 2014). The Re:act Behaviour Change program (hereafter referred to as "Re:act") invites tertiary (university and TAFE) communication and graphic design students to create a road safety campaign to help influence the beliefs and behaviours of other young people. Each year, Re:act targets a chosen behaviour that represents a significant road safety risk for young people. Within each jurisdiction where the program is implemented, one selected or 'winning' campaign, is displayed on a range of outdoor media, including billboards and bus shelters, and via program partner networks (Re:act, n.d). Since its inception in 2016, Re:act has been implemented across Australia and internationally (Re:act, n.d.). The evaluations were conducted with funding support from a National Road Safety Action Grant. The grant was awarded to Re:act for them to expand the implementation of Re:act to regional areas of Australia in 2024 and 2025, conduct events aimed at giving young people a voice in road safety, and support evaluation of the program.

Conference theme
This research comprises evaluations of campaigns designed by young people for young people as part of the Re:act program. The findings attest to the positive effects of the campaigns on young people's beliefs and intentions. The project highlights the value of collaboration between academia and industry together with government funding support in optimising efforts to engage young Australians and help shape a brighter future for road safety among young people.

Method
Informed by the SatMDT (Lewis et al., 2016), the same methods and materials were implemented for each impact evaluation; varying only in terms of the behaviour of focus and campaign materials shown (i.e., mobile phone distraction in 2024 and seatbelt use in 2025). For the 2024 evaluation, N=643 (Mage=21.9 years, 66.4% female) while, in the 2025 evaluation, N=731 (Mage=21.3 years, 50.5% female) young people aged 18-25 years and living in Australia and not involved in campaign development, completed a 20-minute online survey. Participants were randomly allocated to view one of six campaigns or a control (no campaign) condition (Figure 1 and 2 for the 2024 and 2025 campaigns, respectively). Online panel providers recruited the participants. To assess effectiveness, campaigns were evaluated via various outcome measures including *direct measures of effectiveness* including message effectiveness, efficacy, message rejection, and the third-person effect (i.e., perceived influence of a message on self versus others) as well as *indirect measures of effectiveness* relating to intentions to use a mobile phone (in 2024) or to wear a seatbelt (in 2025).

Results
Tables 1 and 2 summarise some of the key results for the 2024 distraction campaigns and the 2025 seatbelt campaigns, respectively. Please note that page-number restrictions prevent all the results from being outlined herein.

Implications for policy and/or practice
The study supports the on-going implementation of the Re:act program in regional and metropolitan locations around Australia. Currently representing the only tertiary mandatory program in the nation, the results provide support for the program as a behaviour change initiative to improve road safety for young people. The project also highlights the

benefits that can be achieved through collaborative efforts comprising academic-based evaluations of industry-led initiatives through funding support for such research through government partners.

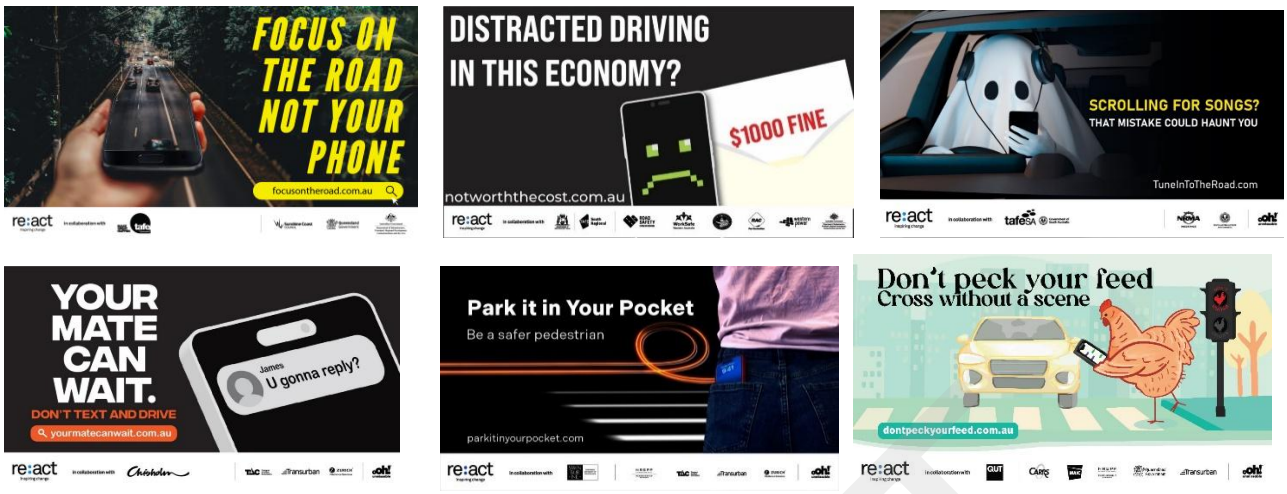

Figure 1. Campaigns 1 through to 6 (L-R) selected from the 2024 Re:act program for the impact evaluation

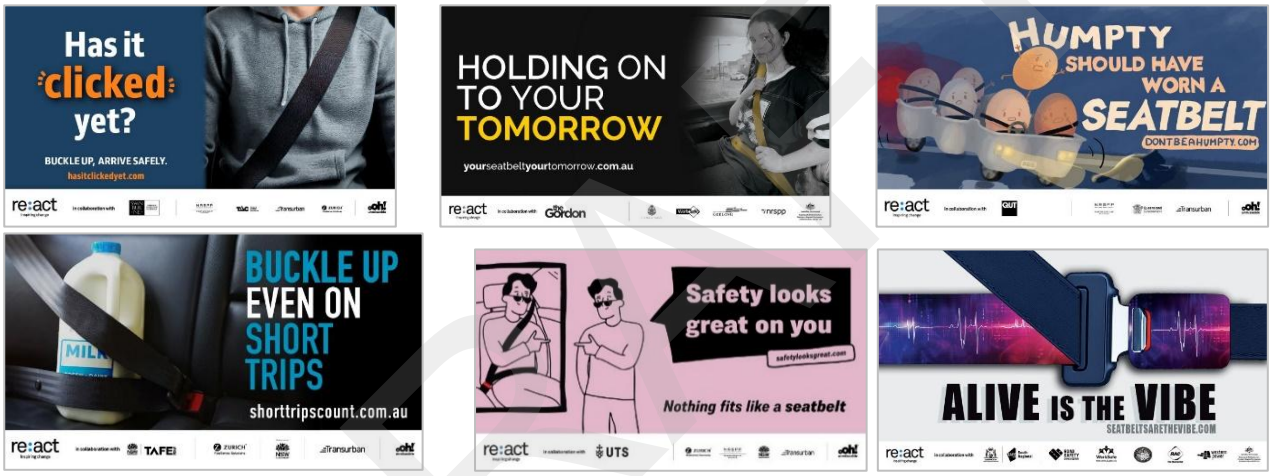

Figure 2. Campaigns 1 through to 6 (L-R) selected from the 2025 Re:act program for the impact evaluation.

Table 1. Some key results of the measures of effectiveness from the 2024 Distraction campaigns

Message Effectiveness	• Campaigns targeting driver distraction were generally considered more convincing and persuasive than those targeting pedestrian distraction.
	• Campaign 4 (*Your mate can wait*) was found to be the most effective, receiving significantly higher mean scores compared to Campaigns 2, 5 and 6.
	• Campaign 6 (*Don't peck your feed*) was found to be least effective, receiving significantly lower mean scores compared to Campaigns 1, 4, and its fellow campaign targeting pedestrian distraction - Campaign 5.
Response and Message Efficacy	• Campaign 4 (*Your mate can wait*) received the highest mean efficacy scores for avoiding driver mobile phone use, while Campaign 5 (*Park it in your pocket*) received the highest mean efficacy scores for avoiding pedestrian mobile phone use.
	• Campaign 6 (*Don't peck your feed*) was associated with the lowest mean efficacy scores in terms of offering strategies and information for avoiding driver mobile phone use but was still considered stronger than some driver campaigns for avoiding pedestrian mobile phone use (i.e., Campaigns 2 and 3).
Third-Person Effect (TPE)	• Reverse TPEs (i.e., whereby individuals report a message will influence them more than *others*) were found for all campaigns except Campaign 6 (*Don't peck your feed*). This finding is encouraging as TPE reversals highlight an individual's propensity to being influenced by the campaign.
Message Rejection	• Overall, participants across all conditions were generally neutral about whether they would ignore or consider the campaign if they saw it in a public setting.
	• However, participants who viewed Campaign 4 (*Your mate can wait*), were significantly more likely to engage with the advertisement compared to Campaign 2 (*Distracted driving in this economy?*).

Table 2. Some key results of the measures of effectiveness from the 2025 Seatbelt campaigns

Message Effectiveness	No campaign was found to be significantly more effective than any other.
	Age had a significant impact on mean effectiveness scores, with older participants considering the campaigns more effective than younger participants.
	All campaigns were considered convincing and persuasive to some extent (i.e., scores of 4 to 5 on a 7-point scale).
Response Efficacy	Age had a significant effect in the driver context, with older participants agreeing more strongly that the campaign provided useful information to encourage seatbelt use.
	No significant findings between campaigns were observed for the passenger context.
	No campaign was significantly higher in response efficacy than any other in either the driver or passenger context. However, Campaign 3 (*Humpty should have worn a seatbelt*) received the highest mean score, and Campaign 4 (*Buckle up even on short trips*) received the lowest score in both contexts.
	Overall, participants agreed to some extent (i.e., scores of around 4 on a 7-point scale) that the campaign they viewed offered useful information and strategies to encourage people to wear seatbelts.
Self-Efficacy	Gender was found to have a significant effect in the driver context, with male participants more strongly agreeing than females that the campaign they viewed offered information and strategies about seatbelt use that they could adopt.
	For the passenger context, a significant effect was found for campaign viewed, with participants who viewed Campaign 1 (*Has it clicked yet?*) more strongly agreeing that the campaign provided useful information that they could personally use, compared to those who viewed Campaign 4 (*Buckle up even on short trips*).
	Overall, participants agreed to some extent (i.e., scores of around 4 on a 7-point scale) that the campaign they viewed offered information and strategies that they could use.
Third-Person Effect (TPE)	Female participants across all six campaigns considered the message to be more influential on themselves compared to other road users in general (i.e., reverse TPEs).
	For male participants, Campaigns 3, 4, and 6 were more personally influential (i.e., reverse TPEs), while they reported that Campaign 1 would be more influential on others than on them personally. There was no difference in scores for Campaigns 2 and 5 and suggests that males who viewed these campaigns considered the campaign message to be equally as influential on themselves as it would be for others.
	Overall, these findings are encouraging as TPE reversals highlight an individual's propensity to being influenced by a campaign.
Message Rejection	No campaigns were found to be significantly more likely to be rejected than any others.
	Campaign 3 (*Humpty should have worn a seatbelt*) was the least likely (albeit not significantly so) to be rejected.
	However, scores were around the mid-point of the measure, suggesting that, overall, participants were ambivalent about whether they would ignore the campaign or engage with it if they saw it displayed on an outdoor advertising space.

Conclusions

Overall, the findings of two evaluations based on two years of campaigns produced by students as part of the Re:act program indicate that the campaigns developed within the program are associated with positive impacts on young persons. This conclusion is based on nation-wide surveys of 18–25-year-olds over two separate years and in relation to two different campaigns produced by students of the Re:act program. Overall, the findings highlighted that there were some notable positive effects associated with campaigns in both 2024 and 2025. Although not possible to compare statistically (given different behaviours), the results suggest that stronger positive results were reported for the distraction campaigns; and this result may be due to the already relatively high compliance rates associated with seatbelt wearing in Australia. However, that said, other measures indicated that participants were identifying positive aspects such as information and strategies to aid them to wear a seatbelt.

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DRAFT

Evidence informing practice: development of road safety education initiatives

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Abstract
Young people are over-represented in road trauma. Road safety education programs represent a key component in efforts to ultimately improve road safety among young people. Evidence supports early intervention; the sooner that road safety education can be introduced, the better. Moreover, to enhance likely positive effects on beliefs and behaviours of young people, education programs must be informed by strong conceptual and empirical bases coupled with approaches featuring peer collaboration and a staged, structured and interactive approach to learning. This presentation details designing a road safety program from a collaborative effort involving stakeholders from Queensland, Tasmania, and Western Australia. Systematic literature reviews coupled with findings from workshops, interviews, and surveys with young drivers and their families, generated more than 3,400 touchpoints of community input. This discovery phase of program development has been rigorous and extensive. The results of these methods are outlined and next steps for informing program development presented.

Background
In Australia, young drivers between 17 and 25 years constitute 10-15% of the total number of licensed drivers yet are disproportionally represented among road crash victims. In the years 2013-2023, this demographic accounted for 19% of deaths and 25% of drivers seriously injured in road crashes (BITRE, 2022). While constituting a persistent concern and associated with extensive investment in initiatives and resources to address this cohort, efforts are needed to ensure that the initiatives implemented are evidence-based. And, in the case of education-based programs, must be confirmed that young people engage and connect with such programs and that the programs achieve their intended objectives in improving the beliefs and behaviours of young people. The program of research within which this 'discovery phase' was situated aimed to ultimately inform the development and implementation of road safety education initiatives for young people that are evidence-based and innovative. This paper is the first of two connected submissions with the second submission, *What if we designed this with them, not for them?* This first paper presents the findings from systematic literature reviews of extant evidence together with data-driven insights from crash data. Community insights were then gained from young people and their parent supervisors which, together with reviewed evidence, informed a co-design process that is outlined in the second submission. Both submissions are designed to stand independently, but together they tell a complete and compelling story from evidence to action in the context of informing road safety education design and implementation.

Conference theme
This research epitomises the conference theme of *From Evidence to Action: Shaping a Brighter Future*. The presentation outlines the discovery phase of a program of research which comprised reviews of extant evidence and community insights from young people and their families to inform the design of innovative road safety education initiatives. The project also highlights the power of impactful collaboration with stakeholder input from across three States (Queensland, Tasmania, and Western Australia) and across academic, Government, and industry sectors.

Method

Systematic literature review
The discovery phase commenced with two systematic literature reviews into the broad areas of (i) road safety education and (ii) more general risk management. The reviews were commissioned by the project funder in Tasmania and were undertaken by an independent university research centre in Queensland. The review was to be a key foundational element to help inform the funder's understanding of the evidence base which they would subsequently draw upon to design and deliver an education-based initiative to help reduce the over-representation of young Tasmanian people in road trauma. The reviews implemented were guided by 15 key areas of exploration including, for example, youth psychology and development and considerations for program design and delivery, impact of parents and peers on risk management, engagement methods with youth and parents, as well as the influence of mental health and neurodiversity

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on program design and delivery. Among the databases searched were APA PsycInfo, Informit, and PubMed with key terms and search dates recorded with article selection undertaken systematically, based on the PRISMA guidelines. Grey literature was considered and, indeed, as is noted, additional references were identified based on the research team's expertise and knowledge of recent, unpublished/yet to be published work in the field. Focus was also upon evidence relating to youth aged 13-18 years and recent evidence from the years 2010-2024. For the first search relating to 'road safety driver education and training', 127 papers were eligible for full-text review with 42 of these papers included in the write-up in addition to two further reports deemed relevant (as literature known about by the research team), resulting in 44 papers. For the second search relating to more general risk management, 6 papers were included.

In addition was an overview of the Tasmanian youth crash data and national youth crash data (to observe trends over time with the timeframe extending from 2005-2024). These data were intended to complement the broader evidence base with some up-to-date, data-driven insights about crashes involving young people and the contributing factors. The national youth crash data were derived from already published sources while Tasmania's Department of State Growth provided deidentified crash data to the research team via a data request. The systematic literature reviews and data-driven insights were complemented by extensive subsequent primary data collection to gain community-driven insights. Research to gain insights was conducted in Tasmania and Western Australia (WA) by peak Tasmanian and WA motoring bodies, respectively and comprised community discovery and engagement.

Community discovery: Western Australia

Concurrently, a co-design and innovation team conducted extensive community discovery across 2024-2025 in WA, generating more than 3,400 touchpoints of community input: qualitative surveys with 775 parent supervisors and 285 learner drivers aged 16-25; metro and regional workshops and structured group interviews; a social media campaign generating 6,708 engagements; a 2-day design hackathon with 12 high school students producing 4 concepts; creative responses from TAFE and University students; a People's Choice vote on concept directions (2,027 responses); and a university academic partnership examining rural and regional learner driver needs (Young Driver Road Safety Program WA, 2025).

Community engagement: Tasmania

An $8 million, 5-year government-funded Tasmanian youth road safety project contributed further community evidence through regional consultations, an online forum with the Youth Network of Tasmania, and a co-design session with 27 supervisors and young people facilitated in November 2025 (Youth Road Safety Project Tasmania, 2025).

Results

What the systematic literature reviews and data-driven insights revealed

The following aspects were among key conclusions for road safety program design:

- Design programs using co-design principles that authentically involve youth, parents, and community leaders.
- Deliver content using developmentally aligned, interactive, and multi-modal approaches of real-world scenarios.
- Integrate emotional learning, peer influence strategies, and identity-affirming content to enhance relevance and engagement.
- Ensure programs are accessible to neurodiverse and disadvantaged learners through customisation and educator training.
- Adopt structured parent involvement strategies supported by communication tools and real-time monitoring technologies.
- Evaluate programs using logic models, behavioural outcomes, and consider implementation of frameworks that enable robust and measurable impact.
- Expand training and accreditation for educators and facilitators delivering road safety content
- Address known risk factors (e.g. speeding, phone use) through targeted, evidence-informed messaging and delivery.

While among key findings from the data-driven insights based on the Tasmanian crash and fatality data from 2005 to 2024 (for brevity and space restrictions for this abstract, only the Tasmania youth crash data are presented as opposed to additional national youth crash data), the data, as shown in Table 1, reflect the persistent overrepresentation of young drivers aged between 16 and 25 years in crash and fatality data in Tasmania. Plotting these data revealed a general decrease over the data collection period in absolute number of fatal crashes involving a young person aged 16 to 25 years and crash fatalities of young people aged 16 to 25 years, as well as in the proportion of overall fatal crashes and crash fatalities represented by this age group.

What the community-driven insights revealed

Six themes emerged from community discovery that help to reframe the learning-to-drive experience: supervision is emotionally demanding and relational, parents enter the role without preparation or a framework to guide them, learner confidence and perceived competence diverge dangerously; learning is not one-size-fits-all, safety teaching is improvised and inconsistent, and the system is not equitable, with rural, regional, and low-income families facing

compounding structural disadvantages (Young Driver Road Safety Program WA, 2025; Youth Road Safety Project Tasmania, 2026).

Table 1. Tasmanian crash and fatality data 2005-2024.

Year	Fatal crashes			Fatalities			16-25 year old fatalities – position description			
	Overall[1]	Involving a 16-25-year-old[2]	Proportion of total (%)	Overall	Fatalities of a 16-25 year old	Proportion of total (%)	Driver	Rider	Passenger/ other	Pedestrian
2005	49	20	40.82	51	9	17.65	7	0	2	0
2006	43	20	46.51	55	21	38.18	10	2	9	0
2007	39	17	43.59	45	13	28.89	5	4	3	1
2008	37	16	43.24	39	10	25.64	5	2	3	0
2009	52	23	44.23	63	14	22.22	4	1	9	0
2010	28	10	35.71	30	7	23.33	4	1	2	0
2011	23	6	26.09	24	4	16.67	2	1	1	0
2012	29	8	27.59	31	3	9.68	2	0	0	1
2013	34	13	38.24	35	7	20	0	5	2	0
2014	31	10	32.26	33	3	9.09	1	1	1	0
2015	31	11	35.48	33	10	30.3	4	5	1	0
2016	32	13	40.63	36	9	25	3	4	1	1
2017	31	11	35.48	32	6	18.75	1	2	3	0
2018	31	12	38.71	32	11	34.38	3	4	3	1
2019	29	10	34.48	29	7	24.14	2	3	2	0
2020	32	11	34.38	38	4	10.53	2	0	2	0
2021	32	11	34.38	35	7	20	5	1	1	0
2022	44	16	36.36	50	11	22	4	2	5	0
2023	34	8	23.53	34	4	11.76	3	0	0	1
2024	28	10	35.71	31	7	22.58	2	2	2	1
TOTAL	**689**	**256**	**37.16**	**756**	**167**	**22.09**	**69**	**40**	**52**	**6**

[1] Fatal crashes are designated by the death of a person within 30 days of the crash; [2] Note: fault status is not known or implied; [3] Mean value (2005-2024)

Benefits to road safety

This research provides multi-source evidence to help inform the design and delivery of effective road safety education programs. By synthesising academic literature and data-driven insights (collated by a University partner in one jurisdiction) together with community insight gained from two other jurisdictions within Australia, the findings help to ensure that the next steps of the project in terms of education initiative development are evidence-based. The cross-jurisdictional scope strengthens national relevance and offers a replicable model for evidence-based discovery that any road safety organisation could apply in efforts to devise content and approaches for road safety programs to engage young people and, ultimately, reduce their involvement in road trauma.

Implications for policy and/or practice

Among some of the key implications for practice in the context of the design and delivery of road safety education programs for young people are the following aspects:

- Programs must be rigorously evaluated.
- Parent support must be treated as road safety infrastructure.
- Co-design with young people should be standard practice.
- Equity must be built into program design from the start.

Conclusions

This work offers a most tangible example of how multi-source methods and cross-jurisdictional and cross-sector collaboration may inform the design of road safety education initiatives. In this regard, the work highlights the very process of translating evidence into practice. The findings from this discovery phase were critical in informing key elements relating to program content and delivery. Insights that speak not just to those factors well-established and known to increase risk for young people on our roads but importantly how to present content in programs that is engaging and likely to achieve belief and behaviour-based change that translates into improved road safety outcomes for young people.

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Impact evaluations of RACQ's High School Road Safety Education Programs

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Abstract
School-based road safety education programs represent a key component in efforts to ultimately reduce road trauma among young people. These programs seek to encourage positive changes in young people's road safety beliefs and behaviours. Despite the key role such programs are to play as a road safety initiative, few programs are subjected to rigorous evaluations. Consequently, it is unclear whether the programs are achieving their intended objectives. Based within social psychological frameworks, this research comprised impact evaluations of each of the RACQ's high school programs: Docudrama, Docudrama Virtual, Driver Distraction, Driver IQ – Provisional, and Driver IQ – Learner. Each evaluation was based on a purpose-devised, cross-sectional survey of intervention schools (surveyed after program participation) or control schools (surveyed prior to program participation). While specific program results varied, overall, positive support was found for the programs and their impact upon young people's beliefs and intent/willingness to adopt safe(r) road user behaviours.

Background
School-based road safety education programs seek to increase road safety knowledge and target psychosocial factors that enhance young people's beliefs and behaviours and reduce their risks (Lewis et al., 2021). Evidence on high school-based road safety education programs is mixed, with some studies demonstrating benefits in improving intentions and behaviours such as seatbelt use and speaking up (King et al., 2008) while others show small, transient effects or even unintended negative outcomes (Poulter & McKenna, 2010; Glendon et al., 2014). This presentation outlines the findings of impact evaluations of each of the RACQ's high school road safety education programs: RACQ Docudrama, Docudrama Virtual, Driver Distraction, Driver IQ – Provisional, and Driver IQ – Learner (see: https://www.racq.com.au/about-us/community/educational-programs).

Conference theme
This research provides key insights into the nature and extent to which the RACQ programs are achieving their intended objectives to optimise how the programs communicate road safety messaging and engage with young people as a key high risk road user group. The research also highlights the benefits of impactful collaborations between industry and academia, made possible through funding support from the Queensland Government's Road Safety Community Grants Scheme. These evaluations have helped to inform evidence-based practice in road safety education.

Method
Participants were high school students attending 32 schools (response rate 31.7%) throughout Queensland. The final sample size for participants who completed surveys for each program varied (Table 1) with sufficient statistical power obtained for the planned analyses in most instances. Convenience sampling meant that unequal composition of males and females were recruited in some samples. A cross-sectional between groups study design was implemented with a self-report paper-based survey. The surveys were administered and/or collected by the RACQ facilitators of the programs and/or a school contact person during school hours. Students in schools allocated to the control group (11 schools; 982 students) completed the survey *before* participating in the program; students at intervention group schools (21 schools; 905 students) completed the survey *after* participating in the program. A repeated measures study design was considered and was conducted as part of a previous evaluation of the RACQ's Docudrama program (Lewis et al., 2021). However, with the current evaluations comprising evaluations of the entire suite (and levels) of the programs that the RACQ offers, following much deliberation, one-off surveys for each program and ensuring ability to compare effects with a baseline (pre-program participation) control group was identified as the most feasible research design.

The design of the evaluation was informed by the Step approach to Message Design and Testing (SatMDT; Lewis et al., 2016) ensuring the project was grounded with an empirical social psychological foundation. The SatMDT has been applied in previous evaluations of school-based road safety programs (Lewis et al., 2021). While conceptually similar in terms of key constructs assessed within the surveys, a separate survey was purpose-devised to align with key content addressed in each of the 5 programs. RACQ education team members were consulted for feedback as part of the survey design process. The effectiveness of the programs was assessed in terms of both direct and indirect measures including measures that asked participants to report about the programs and their effects directly (and thus assessed within the intervention schools only) as well as indirect measures that assessed beliefs, intentions, and willingness relating to safe

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road user behaviours (relevant to the content of each program). As the indirect measures did not refer to a program specifically, they were assessed in, and compared between, the intervention and control schools. The Driver Distraction program is intended to be provided as either a 'booster' program for participants who have previously attended RACQ Docudrama or as a standalone program in and of itself. The intervention group sample comprised mainly of participants in both RACQ Docudrama and Driver Distraction.

Table 1. Study samples for each program based on overall sample as well as control and intervention schools.

	Overall sample			Control			Intervention		
Program	**N**	**Mean age (*SD*)**	**Gender**	**n**	**Mean age (*SD*)**	**Gender**	**n**	**Mean age (*SD*)**	**Gender**
RACQ Docudrama	504	16.92 (.66)	F = 55% M = 43%	223	16.82 (.67)	F= 63% M = 37%	281	16.99 (.64)	F = 51% M = 49%
Docudrama Virtual	300	16.71 (.65)	F = 57% M= 40%	224	16.82 (.67)	F = 63% M = 37%	76	16.37 (.46)	F = 55% M = 45%
Docudrama +Driver Distraction	394	17.28 (.38)	F = 34% M = 65%	212	17.23 (.38)	F = 46% M = 54%	182	17.34 (.38)	F = 21% M = 79%
Driver IQ – Provisional	143	17.04 (.48)	F = 51% M = 45%	59	16.91 (.35)	F = 55% M = 45%	84	17.13 (.54)	F = 48% M = 52%
Driver IQ - Learner	546	16.20 (.37)	F = 43% M = 55%	264	16.17 (.35)	F = 49% M = 51%	282	16.23 (.39)	F = 39% M = 61%

Note. SD = Standard Deviation; F = Female, M = Male;

Results

Due to page limitations, results related to each of the direct and indirect measures of effectiveness, and all comparisons between intervention and control group participants, and between male and female participants to be presented cannot be outlined in this abstract. We therefore highlight some results obtained from the assessment of direct measures of effectiveness. Before providing details regarding these findings, it is important to note that, overall, relatively few statistically significant differences were found between intervention and control groups, but it was noted that most measures were very high in both groups and convenience sampling influenced the gender composition of the study's samples which likely affected the effects found.

Some of the key direct measure of effectiveness findings included the TPE results, intentions to adopt the program's recommendations, and program acceptance. The TPE is a judgement contrast whereby individuals identify how much influence they perceive some stimulus (in this case, a program) would have on them relative to others (third persons). Evidence from the road safety literature has well-established that in instances where individuals report reverse TPE and, thus, more influence of a program on self relative to others, then such perceptions have positive implications for behaviour change (Lewis et al., 2007). Intentions to adopt the recommendations of the program were measured by 3 items with higher scores relating to stronger intentions to adopt the program's recommendations. Program acceptance was measured by combining several items which required students to report how engaging, interactive, believable, valuable, and informative they found the program that they participated in.

Table 2. Third-Person Effect (TPE) results in relation to each high school program

Program	**Female (*M*, *SD*)**	**Male (*M*, *SD*)**	***t* test**
RACQ Docudrama	-0.14 (0.96)	0.28 (1.34)	t (268) = 2.96, p = .003, g = .359
Docudrama Virtual	-0.03 (0.85)	-0.26 (1.46)	t (66) = 0.02, p = 981, g = .006
Docudrama + Driver Distraction	-0.16 (1.37)	-0.07 (1.04)	t (124) = -0.36, p = .360, g = -.355
Driver IQ – Provisional	0.10 (0.65)	0.21 (0.91)	t (133) = 0.85, p = .399, g = -.145
Driver IQ - Learner	-0.30 (0.92)	0.28 (1.29)	t (272) = 3.98, p <.001, g = .493

Note, TPE = Third-person effect; *M* = mean score; *SD* = Standard Deviation; TPE calculated by subtracting the mean of the perceived influence on self score from the mean of the perceived influence on others score. Only participants in the intervention condition answered questions about the TPE.

In Table 2, females frequently showed reverse TPEs while males more often showed classic TPEs, with significant gender differences found in the RACQ Docudrama and Driver IQ–Learner programs. However, while not significantly different in magnitude, it is important to note that male participants also showed reverse TPEs in the Docudrama Virtual and Docudrama + Driver Distraction programs. Table 3 demonstrates that both females and males reported strong intentions to adopt recommendations, with significant gender differences only found in the Driver IQ Provisional and Driver IQ – Learner programs. Overall, program acceptance (see Figure 1) was high with average scores for each program being greater than 5 out of 7 as rated by intervention group participants.

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Table 3. Intentions to adopt program recommendations for each high school program

Program	Female (*M*, *SD*)	Male (*M*, *SD*)	*t* test
RACQ Docudrama	5.59, 1.49	5.40, 1.54	t (265) = -1.27, p = .103, g = -.155
Docudrama Virtual	5.12 (1.59)	5.32 (1.49)	t (66) = 0.54, p = .296, g = .130
Docudrama + Driver Distraction	5.48 (1.52)	5.04 (1.36)	t (119) = -1.41, p = .081, g = -.314
Driver IQ – Provisional	5.39 (1.05)	4.74 (1.47)	t (75) = -2.26, p = .013, g = -.511
Driver IQ - Learner	5.73 (1.29)	5.02 (1.43)	t (263) = -4.05, p < .001, -.512

Note. *M* = mean score; *SD* = Standard Deviation. Only participants in the intervention condition answered questions about intentions to adopt program recommendations.

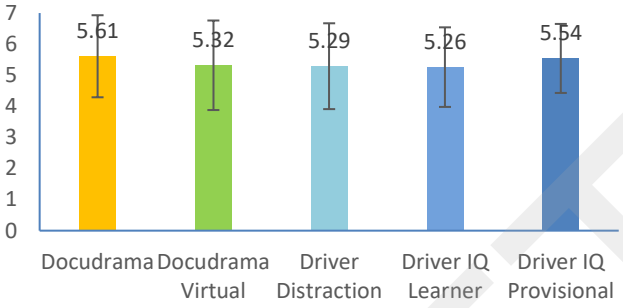

Figure 1. Program acceptance for each of the high school programs based on the 21 intervention group high schools (N = 905)

Benefits to road safety

While acknowledging study limitations including imbalanced gender proportions between (and within) the control and intervention groups due to convenience sampling and the possibility of self-report biases, the study provides support for the positive effects of the RACQ's high school road safety education programs on young people's beliefs and behavioural intentions/willingness. School-based road safety education plays such an important role in helping to prepare young people for what to expect and how to think and behave on our roads. With helping participants to adopt safe(r) road user-related beliefs as well as to identify strategies to help keep themselves and others safe on the roads, the programs offer such a time-critical point of intervention with young people to help enhance road safety outcomes.

Implications for policy and/or practice

The study exemplifies the power of collaboration between government, academic, and industry partners, working together to implement robust methods to support evidenced-based decision making for optimising the content and delivery of road safety education programs for young people. The evaluations offered insights into potential areas of refinement and for future focus including, for example, the potential value of online delivery of the Docudrama program for young males given that this program was one of the few that resulted in reverse TPEs for male participants.

Conclusions

Overall, this research comprising four separate impact evaluations, underpinned by social psychological frameworks, demonstrated that each of the programs was associated with a range of positive effects on psychosocial factors influencing young people's beliefs as well as intentions and willingness. The findings attest to the importance of undertaking conceptually-sound evaluations to better understand the extent to which high school road safety programs are effectively conveying road safety messaging to, and optimising engagement with, young people.

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Are turbo roundabouts safe? A driving simulator study

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Abstract
Conventional double-lane roundabouts have a diminished safety profile compared to single-lane roundabouts including increased speeds and crash rates, warranting investigation into safety treatments. Turbo roundabouts have been suggested to reduce speed and improve navigation at double-lane designs. As such, the present study compared driver behaviour between double-lane and turbo roundabouts using a motion-based driving simulator. Participants ($N = 116$) drove through six designs (two double-lane, four turbo) with varying features (reverse-curve approach and coloured line markings). A linear mixed effects regression model was used to compare speed across the designs. Turbo designs reduced speeds by 9.5 km/h compared to the control. Reverse-curve approach reduced entry speeds at the control designs, but not the turbo designs. These findings provide preliminary evidence of the safety benefits of turbo roundabouts regarding speed reduction for Australian drivers.

Introduction
Roundabouts are a widely used traffic management solution designed to improve traffic flow and reduce conflict points compared to traditional intersections. They are circular intersections with a raised centre island that vehicles traverse around clockwise (in Australia). Single-lane roundabouts, the simplest form, provide efficient circulation for low to moderate traffic volumes and generally result in lower crash severity. However, their capacity is limited, and they can experience congestion during peak periods, reducing effectiveness in high-traffic urban areas (Ahac et al., 2023).

Double-lane roundabouts were introduced to accommodate higher traffic volumes while maintaining the operational principles of single-lane designs. Despite this, they present additional safety challenges, including high traversable speeds, frequent lane-changing, and multiple conflict zones, which increase the risk of collisions (Johnson, 2019; Novák et al., 2018). According to (Mamlouk & Souliman, 2019), injury and fatal crashes were substantially reduced at both single-lane and double-lane roundabouts, by 63% and 84%, respectively. However, while single-lane roundabouts showed an 18% reduction in total crashes, double-lane roundabouts experienced a 62% increase in overall crash frequency.

To overcome these limitations, turbo roundabouts have been proposed, showing potential to enhance safety while maintaining the traffic flow and capacity of conventional double-lane layouts (Leonardi & Distefano, 2023). They retain the benefits of conventional roundabouts but incorporate geometric features such as spiral paths, pre-selected entry lanes, and raised lane dividers to guide traffic, reduce speeds, and minimise conflict zones (Novák et al., 2018). The geometry of turbo roundabouts is designed to reduce crash risk by lowering vehicle speeds and limiting conflict zones (Wankogere et al., 2017).

Driving simulators provide a safe and controlled platform that replicates the physical, visual, and auditory experience of real driving, while allowing experimental reproducibility (Hussain et al., 2026; Marchbank et al., 2025). This study aims to evaluate the suitability of turbo roundabouts as a safety treatment for double-lane roundabouts in Australia using a high-fidelity, motion-based driving simulator.

Conference theme
This study employs high-fidelity driving simulation to evaluate turbo roundabouts as a safety intervention for double-lane intersections in Australia. By examining geometric features and supplementary treatments, it generates evidence-based insights to reduce crashes, improve traffic flow, and inform safer road design, directly supporting ARSC2026's *From Evidence to Action* theme.

Method
The present study compared driver behaviour between the turbo roundabout and a control replica of a double-lane roundabout at Mirrabooka Avenue and Hepburn Avenue in Perth WA. The Western Australian Centre for Road Safety Research (WACRSR) high-fidelity driving simulator was used to conduct this study.
We hypothesised that:

Hypothesis: *The turbo roundabout will reduce speeds at key conflict zones within the intersection compared to the control roundabout regardless of traffic presence.*

Participants

A sample of 116 participants aged between 18 and 80 with a current Western Australia C class driver's license were recruited, with quotas for three different age bands (20 participants each in the bands: 18-24, 24-60, and 60+) to ensure a diverse range of drivers were represented (at least with respect to age and gender).

Design

A within-subjects repeated measures design was adopted to examine driver behaviour across different roundabout designs and traffic conditions. The six roundabout designs included: 1**) Control Reverse-Curve Approach (CR):** Existing roundabout with a reverse-curve approach (current intersection), 2) **Control Straight Approach (CS):** Existing roundabout with the reverse-curve altered to a straight approach, 3) **Turbo Straight Approach Colourless (TS colourless):** Turbo roundabout with a straight approach, 4) **Turbo Reverse-Curve Colourless (TR colourless):** Turbo roundabout with reverse-curve approach, 5) **Turbo Straight Coloured (TS coloured):** Turbo roundabout with a straight approach and coloured line marking, 6) **Turbo Reverse-Curve Coloured (TR coloured):** Turbo roundabout with a reverse-curve approach and coloured line markings.

Traffic conditions

Two traffic conditions were used 1) with traffic (simulated traffic on the roundabout), and 2) without traffic. Simulated traffic was programmed to randomly appear on one roundabout per trial. Traffic consisted of eight vehicles that were programmed to travel straight through the inner lane of the roundabout at approximately 25 km/h to 30 km/h for all scenarios. Traffic was triggered by a 'hit box' 200 metres prior to the intersection, timed so that participants would encounter traffic as they entered the roundabout. No traffic was present on the road prior to the intersection.

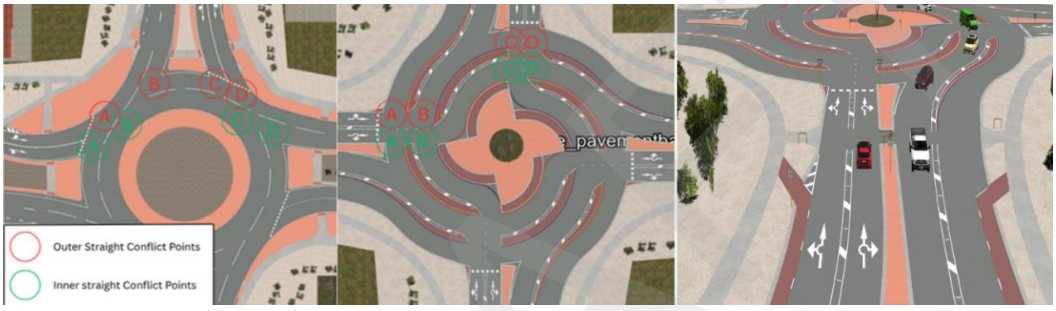

Figure 11. Roundabout conflict zones; (A) Double-lane roundabout, (b) Turbo roundabout, (c) scenario in simulator

Procedure

Participants completed a demographic questionnaire (age, gender, years of driving experience, crash history in the past 3 years) and a 5-minute familiarisation drive to learn simulator controls. In the main task, participants accelerated to 70 km/h and drove through roundabout scenarios while speed data were continuously recorded.

Analysis

A series of linear mixed-effects regression (LMER) models using the GAMLJ3 module were used to test our hypotheses. LMER is a robust approach for repeated measures designs as it does not assume independence or sphericity and can handle missing data that might occur due to simulator sickness, unlike standard repeated measures ANOVA (Kekez et al., 2022).

Results

Table 1 presents the LMER results for the outer-straight (OS) and inner-straight (IS) lanes. Intersection type had a significant effect for both lanes, with turbo roundabouts reducing speeds by 12.2 km/h (OS) and 13.0 km/h (IS) compared to control designs ($p < 0.001$). In the OS lane, a significant Intersection × Traffic interaction showed similar speed reductions under both traffic-present and traffic-absent conditions.

Vehicle speeds varied across roundabout zones and intersection designs in both the outer-straight and inner-straight lanes. Speeds generally increased from Zone A to Zone D, reflecting acceleration as drivers progressed through the roundabout. Conventional roundabout designs (CR and CS) showed consistently higher speeds, while turbo roundabout designs (TR and TS) resulted in lower speeds across most zones. The reverse-curve approach (CS) slightly reduced entry speeds compared with the conventional design (CR), particularly in the early zones. Differences between coloured and colourless turbo designs were minimal, indicating that line colour had little effect on speed behaviour. Overall, turbo roundabouts demonstrated improved speed control compared with conventional double-lane roundabouts.

Benefits to road safety

Turbo roundabouts reduced vehicle speeds compared with conventional double-lane roundabouts, indicating improved speed management and potential reductions in crash risk at high-volume intersections.

Implications for policy

The findings support considering turbo roundabouts as a safer alternative to conventional double-lane designs in Australia, particularly for intersections with high traffic volumes.

Table 1. LMER ANOVA output for the outer straight (OS) and inner-straight (IS) condition. The F-values, marginal R^2 are reported.

Effect	Outer straight				Inner straight			
	F-value	df	df (res)	p-value	F-value	df	df (res)	p-value
Intersection	**575.85**	5	2143.25	**0.001**	**925.13**	5	2498.58	**0.001**
Traffic	0.33	1	2134.81	0.565	0.79	1	2493.83	0.374
Zone	**1017.21**	3	2134.64	**0.001**	**712.99**	3	2493.83	**0.001**
Age	**6.18**	1	51.52	**0.016**	0.37	1	55.09	0.544
Intersection Order	**67.15**	1	2154.45	**0.001**	**21.73**	1	2505.47	**0.001**
Gender	0.3	1	51.27	0.588	0.11	1	54.83	0.745
Intersection*Traffic	**5.2**	5	2134.82	**0.001**	2.03	5	2493.83	0.071
Intersection*Zone	**10.41**	15	2134.63	**0.001**	**32.68**	15	2493.83	**0.001**
Traffic*Zone	**4.78**	3	2134.6	**0.003**	**8.02**	3	2493.83	**0.001**
Intersection*Traffic*Zone	0.66	15	2134.61	0.825	1.54	15	2493.83	0.083
		Model marginal R^2=0.58				*Model marginal R^2=0.58*		

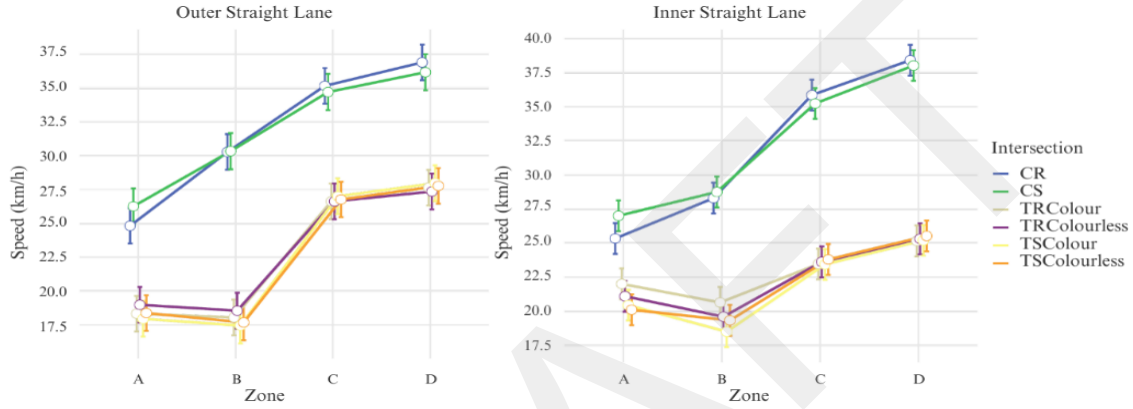

Figure 22. Mean Speed Across Conflict Zones Between Intersection Designs for OS and IS Lane

Conclusions

Turbo roundabouts demonstrated improved speed control in simulated driving conditions, providing preliminary evidence that they may enhance intersection safety for Australian drivers.

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DRAFT

Extended TPB analysis of food delivery rider risky behaviours

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Abstract
Driven by algorithmic pressures in the gig economy, food delivery riders face significant traffic accident risks. Traditional safety theories often fail to explain the complexity of their risky riding behaviours. This study surveyed 135 e-bike food delivery riders in Sydney using an extended Theory of Planned Behaviour. Structural equation modelling was employed to examine the direct and indirect predictors of risky behaviour. Unexpectedly, attitudes and perceived behavioural control did not significantly predict the intention to engage in risky behaviour. Conversely, descriptive norms and injunctive norms significantly increased the intent to engage in risky behaviour, while moral norms significantly decreased this intention. To improve road safety, policy interventions must shift from individual driver education to regulating delivery algorithms, fostering a supportive peer safety culture, and emphasizing riders' moral responsibility.

Introduction
The food delivery industry offers flexible employment and convenience to consumers, but it has also contributed to a growing road safety crisis. Delivery riders, primarily using e-bikes, are among the most vulnerable road users, facing disproportionate risks. Recent accident statistics show that rider injuries and fatalities are rising by 150 per year, and by 2024, 15 food delivery workers in Australia had died (Transport Workers' Union of Australia, 2023).

The causes of these accidents are closely related to the unique working environment of gig workers. Unlike traditional drivers, food delivery riders are subject to strict algorithmic management, strict delivery time limits, and piece-rate wage systems (Nguyen et al., 2023; Zheng et al., 2023). This unstable working environment creates enormous time and financial pressure, often prompting riders to engage in dangerous driving behaviours in order to maximize income or avoid algorithmic penalties (Tran et al., 2022). General risky behaviours include running red lights, speeding, driving against traffic, and being seriously distracted by using a mobile phone while driving (Oviedo-Trespalacios et al., 2022; Qian et al., 2024).

To address this pressing road safety issue, researchers frequently employ the Theory of Planned Behaviour (TPB) or its extensions to understand the sociopsychological determinants of risky riding (Ha et al., 2023). Current research applying Extended TPB to food delivery riders is relatively limited. Therefore, to assess rider safety, extended variables can be introduced to construct a framework. This framework can capture the social, systemic, and ethical dimensions of gig work. By incorporating variables such as descriptive norms, directive norms, and ethical norms, a more accurate psychological profile of riders can be constructed. This study aims to fill this theoretical and practical gap by investigating the direct and indirect predictors of dangerous riding behaviours among food delivery riders. By identifying which specific norms or attitudes drive or mitigate risks in an algorithm-driven environment, this research provides crucial evidence for developing targeted policy interventions and platform regulation safety advocacy campaigns.

Conference theme
This research connects directly with the ARSC2026 theme by addressing the safety issues of gig economy food delivery riders. To provide clear evidence, our study goes beyond blaming individual riders. Instead, we examine how system rules and social pressures cause risky riding. To turn this evidence into action, the findings can guide practical safety steps. By addressing the actual reasons why these workers take risks, this study helps protect riders and build a safer future for urban transport.

Method
This study conducted a cross-sectional questionnaire survey of e-bike delivery riders in Sydney to explore the psychological factors influencing their intention to perform risky behaviours. Data collection took place from November to December 2025, with 135 valid questionnaires collected for final analysis.
The questionnaire was constructed based on the Extended TPB framework. The study collected participants' basic demographic characteristics, accident history, and penalty records, as well as ten core psychological and behavioural

structures: Risky Behaviour (RB), Behavioural Intention (BI), Attitude (AT), Descriptive Norms (DN), Injunctive Norms (IN), Perceived Behavioural Control (PBC), Self-Identity (SI), Moral Norms (MN), Legal Norms (LN), and Sensation Seeking (SS). All theoretical items were measured using a five-point Likert scale, ranging from 1 (strongly disagree/never) to 5 (strongly agree/always).

Data analysis was conducted using SPSS and AMOS software. The analysis process consisted of several main phases. First, descriptive statistics were performed, followed by exploratory factor analysis (EFA). Then, confirmatory factor analysis (CFA) was conducted to validate the fit of the measurement model, examine the convergent validity and composite reliability of each dimension, and assess the discriminative convergence of each dimension. Normality tests and Pearson correlation analyses were performed on the model, and differential analyses were conducted on demographic characteristics. A structural equation model (SEM) was constructed to test the model's overall fit and the direct path relationships among the latent variables (Figure 1). Finally, to examine the mediating role of behavioural intentions using 5000 bootstrap resampling, we calculated the composite mean score for each construct. This step was taken to maintain parameter stability and statistical power during the mediation analysis, given the sample size of 135.

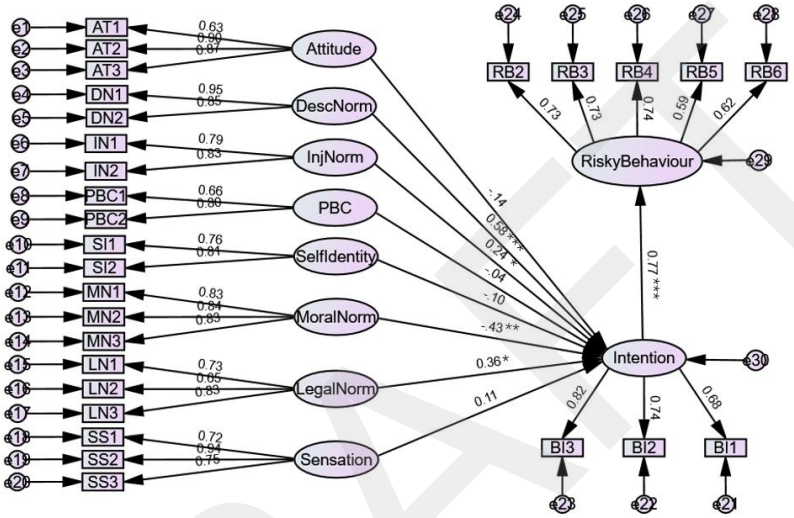

Figure 1. The structural equation model diagram

Results

The study analysed data from 135 e-bike food delivery riders. The sociodemographic profile indicated a predominantly young and male workforce, with 87.4% aged between 18 and 30, and 60.0% identifying as male. Notably, 94.8% held a college degree or above, and 62.2% used leased vehicles for delivery. Prior to hypothesis testing, a Confirmatory Factor Analysis (CFA) established excellent measurement model fit (CMIN/DF = 1.648, RMSEA = 0.070, CFI = 0.898). All constructs demonstrated robust internal consistency, convergent validity (AVE > 0.47), and composite reliability (CR > 0.69).

The path coefficients revealed a striking deviation from the classic TPB. Attitude and PBC failed to significantly predict riders' behaviour intentions to engage in risky riding. Additionally, other extended variables, including self-identity and sensation seeking, did not significantly predict riders' risky behavioural intentions (Table 1). Instead, the direct paths showed that social and systemic norms heavily dictate riders' intentions. Descriptive norms and injunctive norms significantly and positively predicted risky behavioural intention. Conversely, moral norms emerged as a critical protective factor, significantly reducing risky intentions. Furthermore, behavioural intention demonstrated a highly significant direct effect on actual risky behaviours ($\beta = 0.773$, $p < 0.001$), confirming that once the intention is formed under peer and algorithmic pressure, it strongly translates into physical risk-taking.

Subsequent bootstrap mediation analysis corroborated these structural paths. Behaviour intention significantly mediated the effects of descriptive norms ($p = 0.001$), injunctive norms ($p = 0.005$), and moral norms ($p = 0.030$) on actual risky behaviours, while the indirect effects of personal attitude and PBC remained entirely non-significant. Interestingly, Legal Norms positively predicted risky intentions ($p = 0.014$), suggesting a potential defiance effect under strict platform control.

Benefits to road safety

This study improves road safety by fundamentally redirecting intervention strategies for food delivery riders. By revealing that systemic pressures override individual safety attitudes, it prevents the misallocation of resources into ineffective, individual-focused driver education. Instead, it provides evidence that mitigating algorithmic time pressures

and transforming peer safety cultures are the most effective ways to reduce high-risk riding (e.g., red-light running, speeding), ultimately preventing injuries and fatalities among this highly vulnerable workforce.

Table 1. Results of SEM path relationship hypothesis test for TPB factors

Path			Estimate	S.E.	C.R.	P
BehaviourIntention	<---	Attitude	-0.14	0.111	-1.139	0.255
BehaviourIntention	<---	DescriptiveNorm	0.583	0.09	3.752	***
BehaviourIntention	<---	InjunctiveNorm	0.245	0.124	2.213	0.027
BehaviourIntention	<---	PBC	-0.043	0.183	-0.198	0.843
BehaviourIntention	<---	SelfIdentity	-0.098	0.185	-0.645	0.519
BehaviourIntention	<---	MoralNorm	-0.43	0.143	-2.881	0.004
BehaviourIntention	<---	LegalNorm	0.361	0.15	2.455	0.014
BehaviourIntention	<---	SensationSeeking	0.106	0.077	1.148	0.251
RiskyBehaviour	<---	BehaviourIntention	0.773	0.139	6.215	***

Implications for policy and/or practice

The findings yield specific, evidence-based implications to reduce road trauma:
Policy: The strong influence of platform norms indicates riders react to systemic pressures rather than individual choices. Policymakers must regulate delivery algorithms by mandating realistic time windows and decoupling piece-rate pay from delivery speed to reduce structural incentives for risk-taking.

Practice: Since personal attitudes do not predict safe riding, traditional rule-based safety education is insufficient. Instead, safety campaigns should leverage the protective power of Moral Norms by highlighting the human cost of crashes to vulnerable road users, and foster positive, peer-led safety cultures at local delivery stations to reshape descriptive norms.

Conclusions

This study concludes that traditional road safety paradigms, which rely on individual attitudes and perceived control, are insufficient for addressing the complex realities of the gig economy. Our analysis robustly demonstrates that food delivery riders' risky behaviours are predominantly driven by systemic expectations and peer influence (descriptive and injunctive norms), while their internal ethical obligations (moral norms) serve as the ultimate protective buffer.
To address the inherent limitations of self-reported survey data and mitigate social desirability bias, future research will adopt an objective observational approach. Specifically, the next phase of this project involves conducting video recordings at intersections in Sydney. This will allow for the direct observation of e-bike delivery riders' actual behavioural patterns and traffic conflicts in real-world scenarios. Triangulating these objective field observations with the current survey findings will provide a comprehensive evidence base to inform targeted infrastructure and policy interventions.

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DRAFT

Field trial of photoluminescent markings and signs at passive railway crossings

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Abstract
Passive railway level crossings (RLXs) present safety risks at night due to limited visual cues. This study evaluated a low-cost photoluminescent (PL) treatment at a typical passive RLX in regional Victoria. One approach (northbound) was treated with photoluminescent line markings, pavement markings and signs, whereas the remaining approach (southbound) was used as the control approach. A before–and–after traffic speed survey (a total of 7 weeks) was first conducted, followed by an online survey (n = 128). Speed analysis showed that, under nighttime conditions, mean vehicle speeds on the treated approach decreased significantly by 2.8 km/h to 3.7 km/h after installation, while no significant change occurred on the control approach. Survey responses further indicated favourable perceptions of safety benefits and strong public support, with about 90% supporting wider implementation. These findings suggest PL treatments may enhance drivers' awareness of passive RLXs under nighttime conditions in regional areas, encouraging safer approach behaviour.

Introduction
Railway level crossings (RLXs) remain a major road safety concern worldwide, particularly at passive RLXs that rely on driver perception rather than active warning devices. At these crossings, drivers must detect the crossing environment, scan for approaching trains and make safe decisions within a limited time (Larue et al., 2018). Many crashes are associated with drivers' failure to detect the crossing in time or misjudgement, rather than deliberate violations (Australian Transport Safety Bureau, 2024; Larue et al., 2018). These challenges become more pronounced at night, when reduced illumination lowers drivers' contrast sensitivity and impairs the detection of low-contrast objects in the road environment (Wood, 2020).

Improving the visual guidance of road infrastructure can support earlier hazard detection and safer driving behaviour (Zhao et al., 2020). Photoluminescent (PL) materials absorb daylight and emit light at night without electricity, and have recently been explored for road markings on high-risk curves (New South Wales Government, 2024). More recently, PL markings and signs have been proposed to improve driver awareness at passive RLXs under nighttime conditions and have been tested in simulation environments (Nguyen et al., 2025). However, evidence from real-world traffic settings remains limited. This study addresses this gap by evaluating a PL treatment at a typical passive RLX in regional Victoria using a before–and–after traffic survey combined with a road-user perception survey.

Conference theme
This study provides empirical evidence of the effectiveness of the PL treatments in improving nighttime safety at passive RLXs. This evidence is critical for informing the potential expansion of this low-cost PL treatment at regional passive RLXs where upgrades to full active systems are often impractical or economically unfeasible.

Method
The field trial was conducted at a passive RLX on Donald–Swan Hill Road, Lalbert, Victoria. The default speed limit is 100 km/h, which is reduced to 80 km/h near the crossing. Figure 1 illustrates the PL treatments installed on the northbound approach on 20 November 2025, including a PL double centreline (530 m), PL give-way line, PL "Rail X" pavement marking, and PL "Railway/Crossing" RX9 signs. The southbound approach received no treatment and served as a control approach. Vehicle speeds were measured using pneumatic tube counters installed at 180 m, 120 m, and 60 m upstream of the crossing (Figure 2). Data were collected during the before period (8 September–6 October 2025) and the after period (24 November–15 December 2025), resulting in a total monitoring duration of 7 weeks.

An anonymous online survey was distributed via social media to drivers in regional areas near the trial site (e.g., local Facebook groups/communities). The survey collected demographics, driving behaviour at passive RLXs, perceived effectiveness of the PL treatments, support for wider implementation, and preferences for RLX treatments. 5-point Likert scale items were used to measure the levels of agreement or support. Participation was voluntary and anonymous, and ethical approval was obtained from La Trobe University (HEC25420). A total of 128 valid responses were collected in January–February 2026. Among respondents, 53.9% were male, 95.3% held a full licence, and 46.9% had previously driven through the crossing with PL treatments installed under nighttime conditions.

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Traffic and survey data were analysed using R. Nighttime observations (21:00–04:00) were selected for the speed analysis as PL treatments are designed to address safety issues under low-light conditions, resulting in approximately 240 observations per period at each site. Vehicle speeds were analysed at the three locations by comparing the treated and control approaches before and after installation. Mean speeds between the before and after periods were compared using t-tests, and changes in speed distributions were assessed with Kolmogorov–Smirnov (KS) tests. Survey responses were summarised using descriptive statistics. The Friedman test followed by the Wilcoxon signed-rank test was employed to assess respondents' preferences for RLX treatments.

Figure 1. PL markings and signs on the northbound approach under nighttime conditions

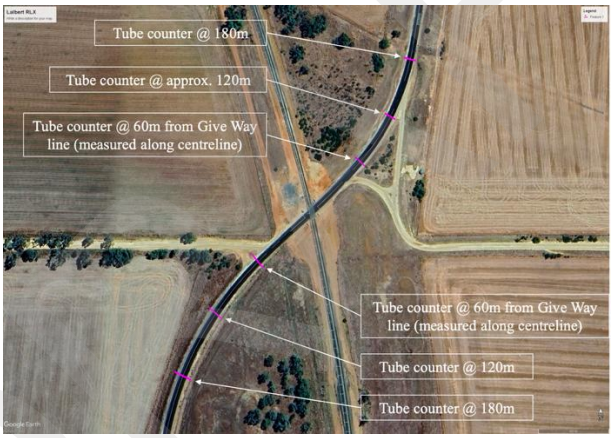

Figure 2. Locations of pneumatic tube counters at the crossing on Donald–Swan Hill Road

Results

Table 1 summarises the results of nighttime speed analysis before and after installation for the treated and control approaches. At 180 m from the crossing, the treated approach showed a significant reduction in mean speed after installation, decreasing from 77.22 km/h to 73.96 km/h (-3.26 km/h, $p < 0.01$). Similar reductions were observed at 120 m, where mean speed on the treated approach decreased from 75.59 km/h to 72.76 km/h (-2.83 km/h, $p < 0.05$). The largest reduction occurred at 60 m, where mean speed decreased from 72.81 km/h to 69.08 km/h (-3.73 km/h, $p < 0.01$). The KS test also indicated significant differences in the speed distributions between the before and after periods at 180 m and 60 m ($p < 0.05$), and a marginal difference at 120 m. Effect sizes (Cohen's d) at the treatment site ranged from -0.23 to -0.29, indicating small-to-moderate effects.

Table 1. Mean vehicle speeds before and after installation of the photoluminescent treatment

Site	Distance to the crossing (m)	Speed (km/h)			p-value		Cohen's d
		Before	After	Difference	t test	KS test	
Control	180	75.83	75.80	-0.03	0.98	0.97	-0.01
	120	72.77	71.91	-0.86	0.43	0.85	-0.07
	60	69.52	69.87	0.35	0.79	0.39	0.03
Treatment	180	77.22	73.96	-3.26	<0.01	<0.01	-0.29
	120	75.59	72.76	-2.83	0.02	0.07	-0.23
	60	72.81	69.08	-3.73	<0.01	0.04	-0.25

In contrast, the control approach showed negligible changes in mean speeds at all distances between the two periods, which were not statistically significant. These results indicate that background traffic conditions and seasonal variations are unlikely to influence potential speed changes at the treated approach. The treated approach showed greater reductions in mean vehicle speed than the control approach, with additional reductions of 3.23 and 4.08 km/h at 180 m and 60 m upstream of the crossing, respectively ($p < 0.05$).

Survey responses indicated strong perceived benefits of PL treatments under nighttime conditions. Most respondents agreed that PL elements would improve crossing detection (82%), earlier speed reduction (85%), lane positioning (84%), and awareness of approaching trains (82%). In addition, 69% of respondents disagreed that PL elements would not improve safety, indicating a generally positive perception of their safety benefits (Figure 3). Support for wider implementation was high, with about 90% of respondents agreeing that PL treatments should be applied at more passive RLXs in regional areas. In addition, respondents significantly preferred the PL treatment over the standard passive RLX ($p < 0.001$).

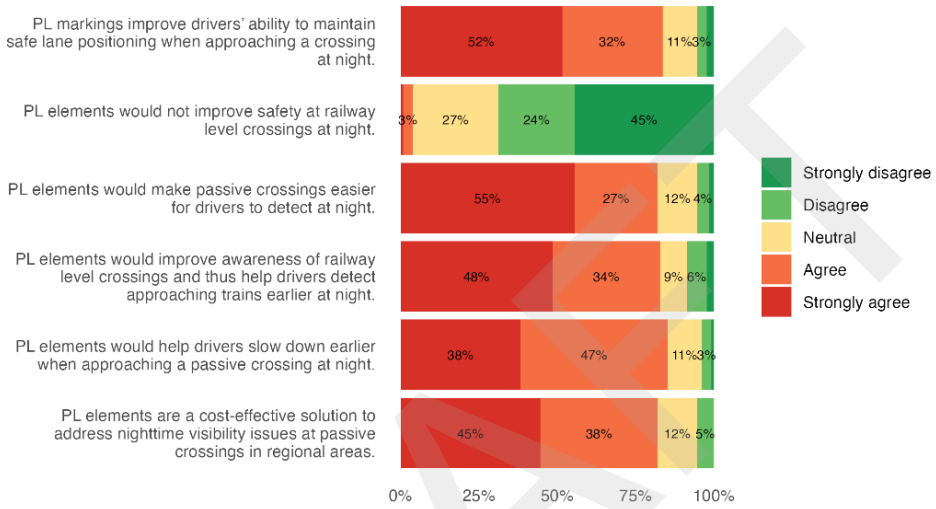

Figure 3. Perceived effectiveness of PL treatments at passive crossings

Benefits to road safety

The results showed reduced nighttime approach speeds from the PL markings and signs, which could be associated with safer approach behaviour and improved safety at passive RLXs under nighttime conditions.

Implications for policy and/or practice

The PL treatment also received strong community support, suggesting that PL markings and signs could be further tested at other passive RLXs in regional areas where active upgrades are unlikely.

Conclusions

This study evaluated the PL treatment at a passive RLX using field traffic data and a road user perception survey. The results demonstrated a reduction in vehicle approach speeds under nighttime conditions, along with strong public support for wider implementation of the PL treatment. Future research should further evaluate the PL treatment at additional sites and monitor its long-term effectiveness.

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DRAFT

Speed bumps on arterials: enhancing motorcycle safety in Bogotá

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Abstract
In Bogotá, speeding on arterial roads is a primary driver of fatal crashes, with vulnerable road users accounting for 97% of deaths. This project shifted from evidence to action by implementing parabolic speed bumps across high-risk arterial corridors. Robust governance and multi-stakeholder collaboration enabled the transition of data and evidence into physical infrastructure deployment that underpinned the project's success. Post-implementation monitoring revealed a statistically significant 69% reduction in fatalities, 58% in serious injuries and a significant improvement in speed compliance (up to 88% reduction in violations). These results demonstrate that when supported by governance, physical infrastructure can effectively mitigate severe and fatal road crashes on high-volume urban arterials.

Background
Vulnerable road users (pedestrians, cyclists, and motorcyclists) account for 97% of fatal crashes in Bogota, with 64% of these fatalities occurring on arterial roads. Speed management is a critical determinant of crash severity. A 2024 observational study by Johns Hopkins University indicated that 42% of all vehicles and 61% of motorcycles in Bogotá exceed posted speed limits. Specifically, on arterial roads with a 50 km/h limit, 32% of vehicles and 54% of motorcycles exceed the threshold. Recognizing this, the Secretariat of Mobility (SDM) developed guidelines based on international and local evidence to evaluate and implement physical traffic calming measures in arterials for the first time aiming at improving motorcycle safety under the safe system approach. The logic behind the measure recognized the linear nature of motorcycle crashes—meaning risks are distributed continuously along a route, necessitating corridor-level interventions rather than isolated, point-level fixes. The need to tackle the speeds of all vehicles (not just motorcycles), the higher prevalence of speeding among motorcyclists, the spacing between measures, the design, and the potential number of lives saved were also key factors (SDM, 2024, 2025; WRI, 2025).

This evidence provided the empirical foundation demonstrating a clear need to transform speeding evidence into life-saving infrastructure on key arterials for the first time. The project was possible due to a multi-layered governance framework that drove the successful transition from evidence to implementation. Central to this was the leadership of the SDM and other institutions under the mobility sector such as the Road Maintenance Unit (UMV) and the Urban Development Institute (IDU). Institutional capacity was bolstered by the Bloomberg Initiative for Global Road Safety (BIGRS) which transferred global knowledge and evidence into this local project. This strategic alliance provided the technical expertise necessary to develop formal guidelines, ensuring that local engineering decisions were backed by international best practices (SDM, 2025). This governance structure allowed the city to bypass traditional resistance to arterial speed bumps by codifying design standards into legally binding technical protocols.

Conference theme
This work directly addresses the ARSC 2026 theme From Evidence to Action: Shaping a Brighter Future. It demonstrates how we are transforming evidence into action through the collaborative deployment of speed bumps in arterial roads, uniting government agencies and international experts. The key message is that high-capacity roads can—and must—be physically calmed to protect vulnerable users using global and local evidence. By challenging the traditional engineering paradigm that arterials cannot accommodate speed management with infrastructure, we provide a proactive, cost efficient and proven effective framework to work on motorcycle safety.

Project description
The project involved the design and installation of parabolic speed bumps across three critical arterial corridors in Bogotá between September 2024 and August 2025. The interventions were led collaboratively by the SDM and urban development agencies, with international expert support from BIGRS. The project included more than 160 speed bumps in almost 10km of the most critical corridors in Bogota (Table 1).

Table 1. Segments analyzed, length, number of speedbumps implemented and date finished. Source: SDM, 2025.

Segment	Length (km)	Number of speed bumps	Date finished
Av. Guayacanes	1.1	10	September 2024
Av. Villavicencio	0.4	6	March 2025
Av. Boyaca (1st phase)	1	20	May 2025
Av. Boyaca (2nd phase)	5.3	82	August 2025

The geometry of the speed bumps was designed for 30, 40, and 50 km/h speeds, dynamically adapting to the regulatory limit based on Danish handbooks included in the local guide created for this project (SDM, 2025). They were spaced systematically (e.g., 150-250 meters apart for 50 km/h zones) to manage speeds at a free-flow level rather than causing stop-and-go congestion. The evaluation involved a post-implementation analysis, comparing historical baseline data (geocoded crash records, Waze travel times, radar speeds and traffic counts) against post-intervention metrics.

Figure 1. Speed bump designed for 50 km/h (left) and 30 km/h (right) based on Danish guidelines.
Source: SDM

Results

The interventions yielded immediate and substantial improvements in safety and speed compliance.

Safety: Safety outcomes were evaluated using a before-and-after observational study design. The baseline period spanned from January 2021 to the month preceding implementation for each respective corridor. The post-intervention period extended from the month following implementation until May 2026. To account for varying implementation dates, raw crash data was normalized into annualized rates for fatalities and monthly rates for injuries. For the second phase of Av. Boyacá, where post-implementation data currently covers less than a full year, annual fatalities were projected based on observed monthly rates. The implementation resulted in a statistically significant 69% reduction in traffic fatalities during the post-implementation period in all corridors (Table 2). Injuries to vulnerable road users also dropped significantly by 58% (Table 3).

Table 2. Change in fatalities per year in the four segments and in total (*90% statistical significance, **95%, ***99%). Source: SDM, 2026

Segment	Base line	Post intervention	Change in fatalities per year
Av. Guayacanes	6	0	-100%***
Av. Villavicencio	3	0	-100%**
Av. Boyaca (1st phase)	3	0	-100%**
Av. Boyaca (2nd phase)[1]	14	8	-43%*
All projects aggregated	26	8	-69%***

Table 3. Change in injuries per month in the four segments and in total (*90% statistical significance, **95%, ***99%). Source: SDM, 2026

Segment	Base line	Post intervention	Change in injuries per month
Av. Guayacanes	4.3	1.6	-63%*
Av. Villavicencio	3.0	0.9	-71%**
Av. Boyaca (1st phase)	4.3	2.1	-51%
Av. Boyaca (2nd phase)	20.6	9.1	-56%***
All projects aggregated	32.1	13.6	-58%***

Speed Compliance: Speed distributions shifted from a mesokurtic (flat, high variance) to a leptokurtic (peaked, low variance) profile, indicating highly uniform, safer traffic flows with fewer instances of sudden braking. Vehicles exceeding the speed limit dropped significantly. On Av. Villavicencio, violations over 50 km/h fell from 35% to 4%, with 97% of motorcycles complying in the fastest direction. On Av. Boyacá, general speeding dropped from 63% to 10%, and motorcycle speeding violations decreased from 85% to 16% (SDM, 2025).

[1] The second phase of the implementation of Av. Boyaca finished 8 months before the data was collected, therefore, this result is the projection for 1 year according to current rates for comparability reasons.

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Mobility: The interventions successfully slowed traffic without causing congestion. For example, traffic volumes on Av. Guayacanes increased by 10%, proving the corridor retained its functional capacity. Travel times increased by marginal averages of 27 to 41 seconds depending on the corridor (SDM, 2025).

Cost efficiency: The measure proved to be highly cost efficient. Based on early estimations, it has a benefit-cost ratio of about 70, assuming the costs of avoided fatalities and injuries calculated via iRAP's methodology. This figure is significantly higher than other measures reported in literature of speed bumps, possibly due to the location in high-risk arterials and its high impact (WHO, 2023).

Benefits to road safety

This work directly benefits road safety by proving that speed management using infrastructure on high-capacity roads aggressively mitigates the risk of severe and fatal collisions without increasing congestion. By enforcing speed limits physically, the project provides immediate protection for vulnerable users, saving lives and the homogenised speed flows fostered better coexistence among different road users.

Implications for policy and/or practice

The outcomes challenge the long-held engineering assumption that physical speed restrictors should be excluded from high-volume arterial roads. The findings provide practitioners with empirical evidence that appropriately designed parabolic speed bumps can effectively calm traffic on arterials without inducing severe congestion or traffic diversion. This creates a validated, replicable framework for translating crash evidence into actionable infrastructure policy on urban corridors globally. The high cost-efficiency of the measure is key for local governments and its magnitude of impact has the potential of having city-wide impact or achieving traffic fatality reduction goals.

Conclusions

The deployment of parabolic speed bumps in Bogotá successfully transformed high-risk arterials into safer corridors, saving lives and decreasing injuries significantly even with a short period of analysis. This collaborative project demonstrates that combining data-driven site selection with geometric engineering allows cities to enforce safe speeds without breaking operational capacity in main roads. To ensure long-term success, actions must prioritize scaling this infrastructure, implementing complementary Safe System measures, and expanding community messaging. Future research should longitudinally assess the durability of safety benefits, shifts in crash typologies, network-wide traffic diversion, and specific impacts on localized congestion and travel times. Finally, formally documenting this multi-agency governance framework will provide a vital blueprint for other jurisdictions attempting physical calming on high-capacity roads.

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Perceptions of speed enforcement: implications for deterrence and procedural justice

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Abstract
Speeding is a leading cause of fatalities in Queensland, although this behaviour remains a difficult one to deter. This study investigated how a dynamic detection method, mobile average speed cameras (MASC), is perceived by the community compared to other traditional enforcement methods. The study also sought to investigate the perceptual factors that may lead to future speeding behaviours within areas hypothetically enforced with MASC. Queensland adult drivers ($N = 887$) completed an online survey about their perceptions on speeding and speed enforcement methods. Results showed MASC offers a higher potential deterrent effect compared to fixed cameras but recieved lower ratings of procedural justice. Participants' attitudes were a strong indicator of the perceived effectiveness of MASC, however, these perceptions remained important for future speeding behaviour, even after controlling for attitudes. To shape a safer future, practitioners should pair technological innovation with transparent communication and community engagement to foster acceptance and compliance.

Introduction
Speeding remains a significant threat to public safety and is a leading contributor to road crashes and fatalities. Within Queensland, speeding is implicated in approximately one-third of all fatal road crashes (DTMR, 2026). Despite ongoing education and awareness campaigns, their impact is often short-lived, as many drivers continue to underappreciate the risks involved (Chen et al., 2022). Of concern, recent research indicates that nearly 80% of Queensland drivers engage in low-range speeding (≤ 10 km/h over the limit), while 40% engage in mid-range speeding and 20% in high-range speeding (Huang et al., 2023). To address this pervasive issue, various enforcement strategies have been implemented, ranging from traditional police-operated detection to automated static speed cameras. While these methods hold specific strengths, their effectiveness is often limited by their predictability. For example, fixed-location cameras may only mitigate speeding within a specific zone, and the increasing use of mobile phone navigation applications (e.g., Waze) and social media allows drivers to identify enforcement locations, reinforcing patterns of punishment avoidance (Truelove et al., 2025).

Classical deterrence theory (Homel, 1988) suggests that compliance is driven by the perceived certainty of apprehension and the severity, and celerity of punishment. However, personal and vicarious experiences with punishment avoidance often carry more weight in decision-making in that individuals may continue to offend if they, or others they know, have avoided legal consequences while offending (Stafford & Warr, 1993). A large evidence-base indeed supports these theories applied to speeding behaviour (Truelove et al., 2021). This highlights a key limitation of traditional strategies, in that they struggle to keep pace with the dynamic nature of speeding behaviours. Beyond deterrence, perceptions of procedural justice are also considered important for speeding compliance, consisting of four primary components: (a) voice, the perceived opportunity to defend one's self; (b) neutrality, the perceived objectivity of enforcement; (c) respect, the perceived respect received by authorities; and (d) trust, the perception that the sanctioning authority's intentions are genuine (Goodman-Delahunty, 2010). Preliminary findings suggest that when drivers view enforcement as fair and legitimate, they are less likely to speed (Bates et al., 2022). However, pro-speeding attitudes can override these perceptions (Watling et al., 2013), suggesting that even legitimate enforcement may be undermined if individuals hold favourable views toward speeding.

With consideration of the current literature, there is a significant gap in understanding how perceptual factors (i.e., risk perceptions and procedural justice) vary across specific enforcement technologies. Understanding these nuances is essential for developing targeted interventions and for the successful implementation of newer, dynamic technologies that can monitor speeding behaviour over extended distances, such as mobile average speed cameras (MASC). As MASC are not currently operational in Queensland, this study aimed to examine community perceptions of this untested technology, compared to other traditional methods (i.e., fixed spot speed cameras [FSSC], mobile spot speed cameras [MSSC], fixed average speed cameras [FASC]). In addition, the study aimed to investigate what perceptual factors may lead to engagement in speeding behaviours within areas enforced with MASC.

Conference theme
This research embodies the theme "From Evidence to Action" by translating community driven psychological data into actionable strategies for road safety enforcement. While traditional research often focuses solely on the overall deterrent effect of police enforcement, this study investigates how the community perceives specific aspects of different speed

enforcement methods and discusses implications for the impact of speeding behaviour. By identifying how people with varying attitudes perceive different enforcement methods, the findings can inform police about which methods are most effective for deterrence and which methods need further clarification and transparency. Further, the study highlights how an untested method in Queensland (i.e., MASC), representing potentially greater coverage of speeding behaviour and unpredictability of apprehension, may be perceived and welcomed in the driving community. This work moves beyond theory to offer practical guidance for authorities. Specifically, it outlines actionable suggestions to practitioners, such as increasing procedural transparency and community engagement, to help to reduce driver scepticism and resistance to enforcement methods.

Method

This research embodied a method of translating community-sourced psychological data into potential actionable strategies for road safety enforcement. An online survey was promoted to Queensland residents via targeted Meta advertising. Participants (N = 887) were eligible if they were aged 18 years or older, held a valid driver's licence, and drove at least one hour per week. The majority of the sample was male (71%) with an average age of 43 years. Participants resided in regional areas (45%), metropolitan (41%), and rural (14%) areas. Notably, 75% of participants had received a speeding fine in the last five years and 80% reported using technology (e.g., Waze) to identify enforcement locations.

After providing informed consent, participants were presented with an overview of different speed enforcement methods and asked to rate 10 items on how they strongly perceived the associated apprehension likelihood, punishment avoidance, deterrent effectiveness, and procedural justice (fairness, respect, trust, and voice). In addition, participants were also asked to complete a multifaceted scale measuring various pro-speeding attitudes, which was developed as part of the current project. All items across the survey were scored on a five-point scale with various context specific anchors attached to each item (e.g., "strongly disagree to strongly agree").

The data were analysed in SPSS 29 using a combination of comparative and correlational analyses. First, one-way repeated measures ANOVAs to compare perceptions of the different enforcement methods. Second, hierarchical regressions to determine perceptual predictors of speeding in areas enforced by MASC. Third, K-means cluster analysis classified participants into weak (n = 405) and strong (n = 482) speeding attitude groups to compare situational MASC perceptions via a MANOVA.

Results

Comparative Perceptions

MASC occupied a distinct "middle ground" in the enforcement landscape. Participants perceived the likelihood of apprehension for MASC to be significantly higher than fixed-location or spot methods like FSSC and FASC, yet lower than MSSC. Conversely, MASC was viewed less favourably regarding procedural justice, receiving lower ratings for fairness, respect, and trustworthiness than established fixed methods. Figure 1 shows the mean perception scores across each enforcement method. Regardless of community perceptions, MASCs do hold the systemic benefit over other methods of controlling speeding for an extended distance rather, than a single static location.

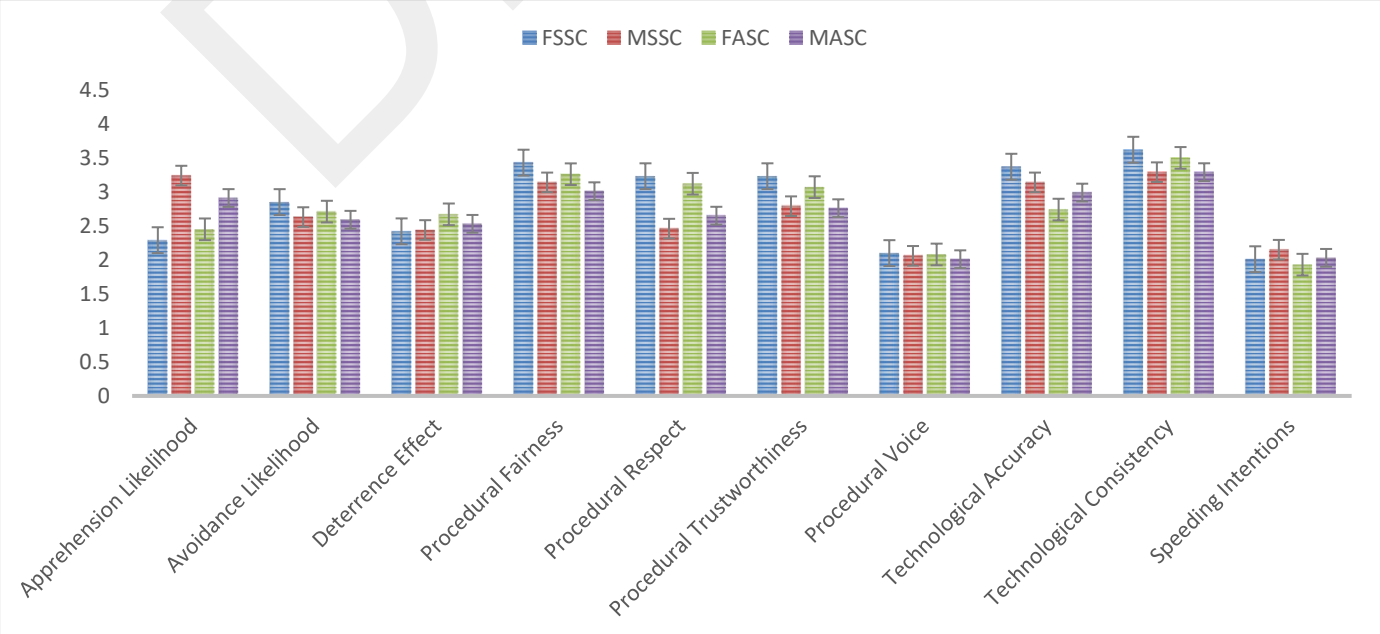

Figure 1. Mean perceptions about the different speed enforcement methods

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Predictors of Speeding Intentions

Pro-speeding attitudes toward speeding were the strongest predictor of speeding intentions in areas hypothetically operating MASC ($\beta = .24$, $t = 5.69$, $p < .001$, $\partial r^2 = .036$). Once these attitudes were controlled for, apprehension certainty ceased to exert a significant influence on speeding intentions for MASC. However, perceived: punishment avoidance likelihood ($\beta = .18$, $t = 5.57$, $p < .001$, $\partial r^2 = .035$), effectiveness ($\beta = -.10$, $t = -2.94$, $p = .003$, $\partial r^2 = .010$), fairness ($\beta = -.12$, $t = -2.49$, $p = .013$, $\partial r^2 = .007$) and voice ($\beta = .08$, $t = 2.46$, $p = .014$, $\partial r^2 = .007$ remained robust, unique predictors of future speeding behaviour in areas hypothetically enforced by MASC.

Benefits to road safety

This research provides evidence to support the integration of MASC into more traditional spot-speed detection methods. The study demonstrates that MASC could add value to speed enforcement by addressing the limitations of predictable, fixed-location enforcement by providing significantly higher perceived apprehension certainty than static methods. Furthermore, by establishing that procedural justice is a unique predictor of speeding intentions for MASC, this work offers a pathway to increase voluntary compliance through the enhancement of public legitimacy. Finally, the research highlights the necessity of targeting the moral disengagement that allows high-risk drivers to justify non-compliance.

Implications for policy and/or practice

To reduce trauma from road crashes, enforcement agencies could consider the rollout of MASC alongside transparent communication regarding technological accuracy and the safety-based motives for specific enforcement zones. MASC may offer a positive solution to enforcing roads over extended distances in environments that have not previously been feasible to enforce (e.g., rural roads). Because punishment avoidance remains a robust predictor of speeding likelihood, the technology should be deployed in a manner that limits predictability to effectively counteract the use of enforcement-avoidance technologies. Additionally, since pro-speeding attitudes are the strongest single predictor of speeding intentions, technological innovation must be integrated with behavioural interventions that specifically challenge the normalisation of speeding. These findings suggest that fostering public acceptance through fairness and respect is as vital as the technology itself for achieving sustained road safety outcomes.

Conclusions

This study identified that MASC occupy a distinct "middle ground" in the enforcement landscape, offering higher perceived apprehension certainty than traditional fixed-location methods but facing greater scrutiny regarding procedural fairness. A significant finding is that while pro-speeding attitudes are the strongest predictor of speeding intentions, procedural justice remains a unique predictor of compliance for MASC. These results sugest that the impact of emerging automated technologies is shaped not only by their deterrence capacity but also by their public legitimacy. Future research should prioritise longitudinal designs to assess how real-world familiarity with MASC influences these perceptions over time and evaluate the effectiveness of specific communication strategies in fostering public acceptance.

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Lessons from analysing the mandatory alcohol interlock scheme (MAIS)

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Abstract
This study presents an evaluation of the South Australian Mandatory Alcohol Interlock Scheme (MAIS) using 14 years of licensing and offence data. Drivers who had committed a MAIS qualifying offence were identified and survival analysis was used to investigate their rates of participation in the program, rates of completion, and rates of recidivism. During this investigation a number of lessons were identified around the complex operation of interlock programs regarding aspects such as the handling of interstate or overseas licence holders, drivers on disqualifications for other offences, and unlicensed or learner drivers, as well as the vagaries of the court system, and how data on licence holders are tracked. These lessons can help to inform improvements to the operation, monitoring, and evaluation of other driver behavioural programs.

Introduction
Alcohol interlocks are devices that prevent a vehicle from being started if a breath sample provided by the driver indicates recent alcohol consumption. Alcohol interlocks are used mostly by licensing authorities as a means by which to prevent drink driving by convicted drink driving offenders.

In May 2009, South Australia transitioned from a Voluntary Alcohol Interlock Scheme (VAIS) to the Mandatory Alcohol Interlock Scheme (MAIS) in which any driver committing a serious drink driving offence was required to serve a disqualification period (length depending on offence severity and prior offence history) and then have an interlock fitted to their vehicle for a period of time (generally equal to their disqualification) before they were able to return to a licence without interlock conditions. A serious drink driving offence was defined as any of the following:

- An offence that involves being detected with a blood alcohol concentration (BAC) above 0.15gm/100ml (Category 3 offence)
- An offence that involves driving under the influence of alcohol (DUI)
- An offence that involves refusing to submit to a Police directive to undertake alcohol testing (Refusal)
- An offence that involves being detected with a BAC between 0.08 and 0.149gm/100ml (Category 2 offence) after committing a previous drink driving offence of Category 2 or greater within the last five years (both DUI and Refusal type offences were considered to be greater than a Category 2 offence)

Given the length of time over which the SA MAIS has been operating, it was timely to perform an analysis of effectiveness. A recent Australian publication by Roberts and Meuleners (2023) suggested four key metrics for the effectiveness of alcohol interlock schemes: offence recidivism, crashes, breath test violations, and program participation. For the analysis of such metrics, previous research studies (Blom & Weijters, 2024; Vanlaar et al., 2017; Voas et al., 2016) have utilised a technique called survival analysis (Kaplan & Meier, 1958) which provides a robust method to account for the continuous entry and exit of drivers into an interlock scheme over time.

Based on available data, it was not possible in the current study to explore breath test violations, but survival analysis was applied to investigate program participation, offence recidivism, crash experiences, and offence experiences of drivers who qualified for the SA MAIS. During the study analysis, a number of interesting factors were identified regarding the unexpected ways that drivers, the court system, and the licensing system interact with or influence the MAIS. This provided an opportunity to perform a qualitative exploration of these factors to identify lessons that may be useful for future studies on interlock schemes as well as in designing behavioural deterrents in general.

Conference theme
This study explores the evidence behind the effectiveness of alcohol interlock programs, as well as providing lessons about the practical operation of such programs to help inform improved monitoring and evaluation.

Method
Licensing and offence data pertaining to any drivers who had committed any type of alcohol offence from 1 January 2010 to 31 December 2023 were extracted from the South Australian Transport Regulation User Management Processing System (TRUMPS). These datasets were de-identified but contained details about each driver's date of birth,

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gender, Aboriginal or Torres Strait Islander (ATSI) status, and residential postcode, as well as any associated licensing events such as issuing of licences, renewals/reissues, offences, disqualifications, or alcohol interlock requirements. After committing a MAIS qualifying offence, a driver is then required to transition through several phases before they can regain a licence without interlock conditions. A typical transition would be expected to proceed through the following phases, in order:

- A driver commits a MAIS qualifying offence
- They serve a period of disqualification
- They elect to obtain a licence with interlock conditions and install an alcohol interlock
- They serve a period with the alcohol interlock
- They regain a licence without interlock conditions

Processes were developed to identify within the licensing data the time that each driver transitioned from one phase to another (if at all). A series of analyses (using survival analysis techniques) were then conducted to explore the characteristics of drivers who qualified for MAIS, the rate of interlock uptake, the rate of MAIS completion, the rate of repeat MAIS offences, the rate of injury crash involvement, and the rate of offences being committed. In conducting these analyses, several interesting factors that can alter the typical transition process were identified and these provided important lessons regarding aspects of the licensing system which are seldom considered.

Results

There were 22,023 instances of drivers committing a MAIS qualifying offence within the 14 years of data available. Figure 1 shows the Kaplan-Meier cumulative probability plot of interlock installation by days since MAIS qualifying offence, MAIS completion by days since interlock installation, and MAIS reoffence by days since MAIS completion.

The probability of interlock installation increases rapidly after the first year once drivers transition through their disqualification period. Over the course of the second year, the probability that a driver will obtain an interlock rapidly rises to over 40% then continues to increase over time (but at a continuously slower rate) to a maximum of approximately 72% by the end of the analysis period. The probability of MAIS completion increases slowly over the first year to around 5% then rises rapidly as drivers are typically required to have an interlock installed for the same amount of time as their initial disqualification period. By the end of the second year the probability of completion has reached around 75%. A second sudden increase at the three-year point, to a completion probability of over 90%, is likely to be associated with those drivers who were handed a three-year disqualification period. There is a small, but gradual increase in probability of MAIS reoffence over time but only to a peak value of around 11%.

Investigating the transition of MAIS qualifying drivers from one phase to the next identified several interesting factors. The disqualification period associated with a MAIS qualifying offence is often designated during a court process that takes into account prior offences and other relevant circumstances. The designated disqualification period can then be amended over time due to appeals or if a driver commits further offences. It is also noteworthy that, commonly, a disqualification does not come into effect until a driver has attended court (and in the meantime they are able to continue driving).

Three factors were identified that could affect the transition time between a driver committing a MAIS qualifying offence, installing an interlock, and completing the MAIS. The first was that a driver cannot apply for a licence with interlock conditions until they have no outstanding fines, suspensions, or disqualifications. Some drivers may be serving a long period of disqualification (such as three years for a repeat drink driving offender), or they may have other/subsequent disqualifications to be served (e.g., unlicensed driving during their original MAIS disqualification period), be suspended or have a cessation of business due to outstanding fines, or they can be in prison, in which case their disqualification does not commence until release from custody.

Second, interlock conditions can only be applied to a South Australian licence. If a driver commits a MAIS qualifying offence while unlicensed or on a learner's permit, the driver must first serve their disqualification period, obtain a learner's permit, and will only be able to obtain a licence with interlock conditions once they are eligible for a provisional licence. Similarly, drivers who committed a MAIS qualifying offence while on a temporary overseas licence would also need to first acquire a South Australian licence before obtaining an interlock.

Finally, it was noted that a proportion of drivers who had committed a MAIS qualifying offence were from interstate (possibly visiting SA). These drivers, who were identified as having an interstate residential postcode, have their offence and MAIS requirements recorded in the TRUMPS system. If remaining in SA, these drivers are required to transition through the MAIS phases in the same way as a local resident (i.e., serve a period of disqualification and then obtain an interlock). Alternatively, offence and court disqualification information can be forwarded to their home jurisdiction. Depending on the interstate jurisdiction, the SA MAIS qualifying offence may result in the driver being required to participate in an interlock scheme within their home state/territory. If the interstate driver later returns to SA

they would need to complete the MAIS before being eligible for a licence, unless they have already served an equivalent interlock period interstate.

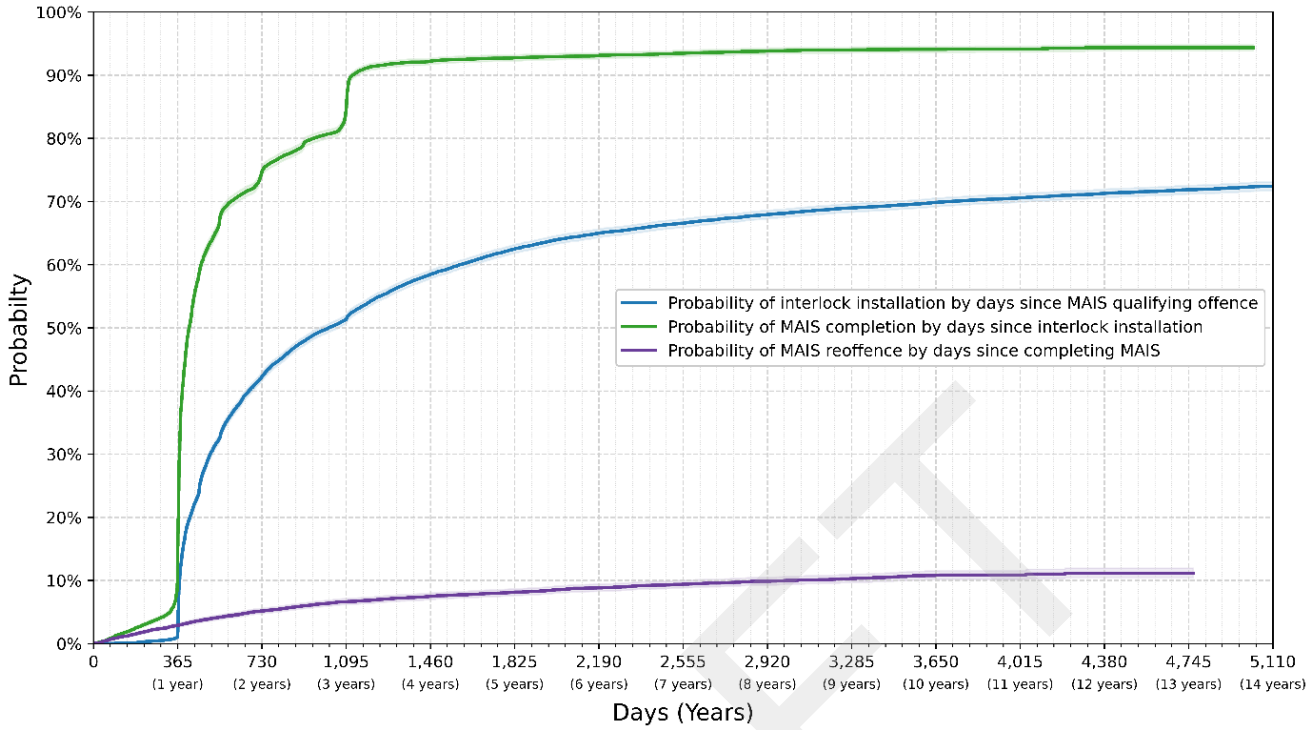

Figure 1. Probability of interlock installation, MAIS completion, and MAIS reoffence over time

Benefits to road safety

The excessive MAIS transition periods and re-offence post completion by some drivers highlights the fact that there are sections of the community who, for various reasons (often outside of the road safety framework), are unwilling or find it difficult to adhere to behavioural driving laws: in this case drink driving laws. This is further support for holistic application of the Safe System approach in which supporting such drivers with targeted assistance schemes which directly prevent dangerous behaviours will have benefits for road safety.

Implications for policy and/or practice

This study provides support for the continued use of interlock programs to limit the road safety risk associated with drink driving, while providing insights into how such behavioural programs should consider the complex interactions that occur within the licensing and court systems to ensure they are effectively monitored and evaluated. For example, there are multiple possible reasons to explain why there may be delays or no transition between interlock program phases, and why interlock uptake or program completion rates will not reach 100%.

Conclusions

The SA MAIS has been effective in limiting the safety risks of drink drivers and encouraging behavioural improvements. However, the licensing and court systems in which the MAIS operates are complex, and these complexities must be accounted for when designing monitoring and evaluation programs, and in the interpretation of findings. Additionally, to achieve maximum effectiveness in preventing drink driving, there is a need to look outside the road safety system and explore potential barriers to participation and completion.

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Understanding driver responses to emergency vehicles

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Abstract
Emergency vehicles using lights and sirens share the road with civilian drivers, who must understand and follow road rules to support safe and timely emergency responses. This program of research involved: (1) a survey assessing driver knowledge via scenario-based items aligned with Queensland legislation; (2) interviews exploring emergency responder perspectives on drivers' responses; and (3) two simulator studies examining driver behaviour in rear-approach, intersection, and stationary emergency-vehicle scenarios, and whether drivers responded independently or followed another vehicle's actions. Across survey and simulator studies, most drivers recognised their obligation to give way, but uncertainty and inconsistent responses occurred at complex intersections and when passing stationary emergency vehicles. Emergency responders described similar patterns of hesitation, sudden braking, and abrupt reactions. Some drivers delayed responses until surrounding traffic moved. Findings highlight gaps in driver knowledge and behaviour that can inform road safety education, public messaging, and policy to improve interactions with emergency vehicles.

Introduction
In 2024-25, Australian emergency services responded to millions of incidents under lights and sirens. Ambulance services alone attended approximately 4.5 million incidents nationally, of which ~46% were classified as emergency responses (Productivity Commission, 2026). During these events, emergency responders (i.e., police officers, paramedics, and fire service personnel) may be conditionally exempt from certain road rules, provided they take reasonable care (e.g., *Transport Operations (Road Use Management—Road Rules) Regulation 2009 (Qld),* s 306). Civilian drivers are required to give way and provide a clear path (e.g., ss 78, 79). Safe and timely emergency responses therefore depend, in part, on drivers' understanding of how to respond to approaching emergency vehicles.

Interactions between emergency vehicles and drivers can occur in complex traffic environments where drivers hesitate, block lanes, stop abruptly, or respond in ways that increase crash risk and/or delay time-critical emergency responses (Hsiao et al., 2018). Existing research has largely focused on isolated road rule provisions (e.g., move-over requirements) and characterising encounters via reports from emergency responders (Grant, 2017; Muir et al., 2020). Less attention has been directed toward understanding Australian drivers' knowledge of multiple emergency-vehicle road rules and how they respond during encounters with emergency-vehicles.

Conference theme
This program of research provides evidence on civilian drivers understanding of road rules and responses to emergency vehicles, with unsafe or delayed responses posing risks to road safety and emergency response times. Findings can inform road safety education, public messaging, and policy aimed at improving how drivers share the road with emergency vehicles to support safer emergency responses.

Method
Four studies were conducted as part of a PhD program of research between 2025 and 2026. Studies examined (1) driver knowledge of emergency-vehicle road rules; (2) emergency responder perspectives on drivers' behaviour; and (3) driver behavioural responses during simulated emergency-vehicle encounters. All studies were approved by the university's Human Research Ethics Committee (Ref Nos: 2025/080; 2025/442; 2025/242).

Study 1: Driver Knowledge of Emergency-Vehicle Road Rules
A sample of 208 Queensland drivers (73 male, 134 female, 1 non-binary; aged 18–55 years, *Mdn* = 19, *IQR* = 3) completed a survey assessing knowledge of emergency-vehicle road rules using illustrated traffic scenarios aligned with Queensland legislation. The sample included 63 Open, 131 Provisional, and 14 Learner class licensed drivers. The survey contained 61 multiple-choice road-rule questions, including 25 emergency-vehicle scenarios embedded among general road-rule items. Participants were tasked with selecting the legally correct action for a specific driver depicted in each scenario.

Study 2: Emergency Responder Perspectives on Civilian Driver Behaviour
Semi-structured interviews were conducted with 18 Australian emergency responders (12 male, 6 female; aged 22–68 years, *Mdn* = 36, *IQR* = 23), including 9 police officers, 7 paramedics, and 2 fire service personnel. Participants reported a median of 7 years of emergency driving experience (*IQR* = 12). Interviews explored their experiences of

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civilian driver behaviour during emergency responses, including patterns of compliance and non-compliance, situational factors influencing driver responses, and perceived gaps in driver education and public understanding of emergency-vehicle road rules.

Study 3: Driver Behaviour During Simulated Emergency-Vehicle Encounters

A sample of 45 licensed drivers from Queensland (22 male, 23 female; aged 18–36 years, *Mdn* = 19, *IQR* = 2) completed a simulated drive. The sample included 18 Open, 22 Provisional, and 5 Learner class drivers. The drive involved six emergency vehicle encounter scenarios: three rear-approach (dual-lane road, single-lane road, and while stopped at a red light with limited space), a give-way controlled intersection with an emergency vehicle approaching from the right, a signal-controlled intersection where the driver faced a green light and the emergency vehicle approached against a red, and passing a stationary emergency vehicle. Compliance was defined as the legally appropriate response in each scenario (e.g., giving way, moving left to clear a path, or leaving one clear lane when passing a stationary emergency vehicle). During a post-drive review, participants also explained what action they believed was legally appropriate in each scenario.

Study 4: Influence of Surrounding Traffic on Driver Responses to Emergency Vehicles

A sample of 51 licensed drivers from Queensland (27 male, 22 female, 2 non-binary; aged 18–41 years, *Mdn* = 21, *IQR* = 4) completed a simulated emergency vehicle encounter at a signalised intersection. The sample included 31 Open, 17 Provisional, and 3 Learner class drivers. Participants were stopped behind a lead vehicle at a red traffic light when an ambulance approached from behind with lights and sirens initially inactive. The roadway included an open lane to the left and a traffic island to the right. Once positioned behind the participant, the ambulance activated its lights and siren without indicating a clear overtaking direction. If the participant did not move within a short delay, the lead vehicle moved onto the traffic island, allowing examination of whether drivers delayed their response and followed the lead vehicle.

Results

Driver Knowledge of Emergency-Vehicle Road Rules

Knowledge of emergency-vehicle road rules ranged from 48% to 100% (*M* = 79%, *SD* = 11). Knowledge scores averaged 76% (*SD* = 12) for items reflecting s.78 (keeping clear of emergency vehicles), 61% (*SD* = 37) for s.78A (passing stationary emergency vehicles), and 89% (*SD* = 10) for s.79 (giving way to emergency vehicles). Self-rated understanding ranged from 2 to 5 (*M* = 4, *SD* = 0.7). A multiple regression model predicting knowledge was significant, $F(5, 201) = 3.40$, $p = .006$, $R^2 = .08$, with licence class the only significant predictor ($p = .025$). Knowledge scores were highest for Open-class drivers (M = 82%), followed by Provisional (*M* = 78%) and Learners (*M* = 75%), with a significant difference between Open and Provisional drivers ($p = .045$). The relationship between knowledge and self-rated understanding followed a cubic pattern ($p = .004$), with higher self-ratings observed among drivers with lower levels of knowledge.

Emergency Responder Perspectives on Civilian Driver Behaviour

Reflexive thematic analysis identified five themes describing emergency responders' experiences of civilian drivers' behaviour during lights-and-sirens responses. Responders reported most civilian drivers attempted to do the right thing, but they were often inconsistent, particularly during rear-approach encounters. Drivers were often described as reacting late, braking suddenly, or making abrupt lane movements when emergency vehicles approached. These behaviours were commonly interpreted as reflecting inattention, hesitation, or panic once the emergency vehicle was detected. Responders reported that road design, congestion, and intersection layouts often limited the actions available to civilian drivers. In response, emergency drivers described adapting their own driving strategies, including adjusting speed, positioning, and signalling to manage unpredictable traffic. Responders further perceived driver education and public messaging about emergency-vehicle road rules to be limited, particularly in more complex situations such as controlled intersections.

Driver Behaviour During Simulated Emergency-Vehicle Encounters

Compliance with the road rules differed across scenarios, $Q(5) = 81.46$, $p < .001$. Compliance was highest in the single lane rear-approach scenario (100%), dual lane rear-approach scenario (98%), and give way intersection scenario (98%). Compliance declined in the signalised intersection scenario where drivers had a green light and the emergency vehicle approached against a red light (74%), and was lowest in the rear-approach while stopped at a red light with limited space (55%) and the passing stationary emergency vehicle scenario (33%). Pairwise McNemar tests showed significantly higher compliance in the dual lane rear-approach, single lane rear-approach, and give way intersection scenarios than the scenarios involving passing a stationary emergency vehicle and rear-approach while stopped at a red light with limited space (all *p*'s < .001).

Influence of Surrounding Traffic on Driver Responses to Emergency Vehicles

Of the 51 participants included in the analysis, 38 (74.5%) changed lanes to the left, 12 (23.5%) moved to the right, and one participant (2.0%) did not move from the centre lane. Movement timing relative to the lead vehicle differed across participants, with 33 drivers (64.7%) initiating movement before the lead vehicle departed, and 17 (33.3%) delaying

their response until the lead vehicle had moved. Drivers who moved before the lead vehicle almost always shifted into the left lane (30/33, 90.9%), whereas those who moved after the lead vehicle were more indecisive between moving left (8/17, 47.1%) and right (9/17, 52.9%). The association between initiation timing and movement direction was significant (Fisher's exact test, $p < .001$).

Benefits to road safety

This research provides empirical evidence on how drivers understand and respond to emergency vehicles in common traffic situations. Collectively, the findings highlight knowledge and behavioural gaps that must be addressed through clearer driver education, scenario-based licensing materials, and public safety messaging. Improving drivers' understanding of how to respond to emergency vehicles will help reduce hesitation and inconsistent responses, supporting safer interactions between emergency vehicles and civilian traffic.

Implications for policy and/or practice

The findings suggest current driver education and licensing materials may provide limited guidance for several types of emergency vehicle encounters, particularly at signalised intersections, when space is constrained, and when passing stationary emergency vehicles. Incorporating clear, scenario-based instruction into learner and provisional driver education may improve drivers' understanding of how to respond in these situations. The results also point to the value of clearer public safety messaging about emergency-vehicle road rules, particularly in situations where drivers are more likely to hesitate or look to surrounding traffic for cues that guide responses. This is consistent with emergency responders' perceptions that practical guidance is limited during complex emergency vehicle encounters. Targeted communication efforts that demonstrate practical responses to common emergency vehicle encounters may help reduce uncertainty and inconsistent behaviour, supporting safer interactions between civilian drivers and emergency responders.

Conclusions

Across a program of research involving four studies, gaps in driver knowledge of emergency-vehicle road rules and variability in how drivers respond to approaching emergency vehicles were observed. Emergency responders frequently described inconsistent or reactive driver responses during rear-approach encounters, and simulator findings indicated that driver decisions can be influenced by the actions of other vehicles. Together, the findings suggest a need for clearer driver education and public messaging to support safer responses during emergency vehicle encounters.

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Shared and private e-scooter safety: a 12-month longitudinal study

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Abstract
E-scooter safety concerns are rising, yet little evidence compares the safety of shared and private e-scooters or how it changes over time. We followed an Australian cohort of riders (baseline and 12-month follow-up; retained n = 361). At follow-up, most recent incidents were disproportionately on private e-scooters (49 of 79 near-misses; 19 of 23 crashes) despite 52.1% of the sample riding only shared e-scooters. Shared e-scooter incidents were more often attributed to device/operational problems or fixed objects while private e-scooter incidents more often involved other road users. Adjusted model results showed the near-miss rate per ride was 23% lower at follow-up, and 42% lower in Victoria than in Queensland. Ownership was not statistically significant after adjustment for sociodemographic factors. Together, the decline in per-ride rate over time and the distinct attribution patterns support prioritising early-use onboarding and training, alongside targeted infrastructure, conflict-reduction measures, and region-specific safety responses.

Introduction
E-scooter use has expanded rapidly and has been accompanied by rises in emergency presentations internationally (Hartz et al., 2025; Liu et al., 2025; Seitakari et al., 2025; Shichman et al., 2022). Australian data reflect the same trend. Haghani (2025) compiled publicly reported e-scooter fatalities from 2020 to mid-2025 and found a rising trend, with fatalities concentrated disproportionately in the state of Queensland. However, existing evidence relies heavily on hospital records, police records, and cross-sectional surveys. To date, no study has followed the same shared and private riders over time, limiting causal inferences about how experience affects safety in these two groups. Our study addresses two key gaps by: (1) comparing characteristics and rider attributions for respondents' most-recent near-misses and crashes on shared versus private e-scooters at follow-up, and (2) estimating within-person changes in per-ride near-miss rates over 12 months.

Conference theme
This study addresses the ARSC2026 theme, *From Evidence to Action: Shaping a Brighter Future*, by translating longitudinal micromobility safety evidence into clearly defined intervention priorities at a time when jurisdictions risk missing 2030 injury-reduction targets.

Method
The Safer Scooting Study included online surveys at baseline (July 2023-June 2024) and 12-month follow-up (July 2024-June 2025) across Australian states and territories. The present analysis is restricted to riders in jurisdictions with broadly comparable regulations governing private and shared e-scooter use at the time of data collection: Queensland, Victoria, Western Australia, the Australian Capital Territory, and Tasmania. Eligible participants were residents aged 18 years or older who reported having ridden an e-scooter. The analytic cohort comprised 361 participants who completed both waves (59% retention rate).

The present research analysed sociodemographic characteristics, e-scooter ownership, ordinal frequency of private and shared rides, counts of near-misses and crash types, and detailed characteristics and attributions of the rider's most recent near-miss and crash at follow-up. Ride frequency bands were converted to numeric exposure estimates using category midpoints. The open-ended "51+" category was coded as 75 rides. For near-miss and crash count variables, responses of ">3" were coded as 4. Descriptive comparisons contrasted most recent-event characteristics by e-scooter type. Longitudinal modelling of near-miss counts used a negative-binomial GLMM with a participant random intercept and the log of estimated rides as an offset to yield per-ride incidence rate ratios (IRRs). Robustness checks included alternative top-coding and Generalised Estimating Equations (GEE).

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Results

Of the 361 valid responses at follow-up, 34.1% had ridden only private e-scooters, 52.1% had ridden only shared e-scooters, and 13.8% had ridden both in the previous year. Respondents reported 79 most-recent near-misses (49 on private e-scooters, 30 on shared e-scooters) and 23 most-recent crashes (19 private, 4 shared).

Most recent near-miss and crash characteristics

Road users involved

Most near-misses (59 of 79, 74.7%) involved another road user. The other road user was most commonly a car (24 of 59, 40.7%) or a pedestrian (19 of 59, 32.2%). For each road-user category, a larger proportion of near-misses occurred on private e-scooters: for near-misses with cars 15 of 24 (62.5%) were on private e-scooters, for pedestrians 12 of 19 (63.2%) were private, and for other road users 9 of 12 (75.0%) were private. However, shared e-scooter near-misses were relatively more likely to involve fixed objects or occur without another road user. Most crashes (16 of 23, 69.6%) did not involve another road user. When another road user was involved (7 of 23 crashes), cars predominated (6 of 7). These crash patterns should be interpreted cautiously given the small number of crashes overall (n=23) and particularly the small number involving shared e-scooters (n=4).

Rider attributions

Riders rated the degree to which they attributed their most recent near-miss or crash to each of various factors on a four-point Likert scale ranging from “Not at all” to “Very much”. For near-misses, road infrastructure and maintenance received relatively high mean ratings for both e-scooter types (shared mean=2.6, private mean=2.4). Shared e-scooter near-misses were more likely to be attributed to the e-scooter and its operation (mean = 2.6). Private near-misses were more likely attributed to other road users (mean=3.1). For crashes, the patterns were similar but sample sizes were small. Lack of riding experience was rated highly for shared e-scooter crashes (mean=3.0). The difference between shared and private incidents in the attribution of “lack of riding experience” was statistically significant (ANOVA $p < 0.001$).

Longitudinal analysis of near-miss rates

A negative-binomial GLMM with a participant random intercept and exposure offset was used to estimate within-person changes in near-miss rates per ride. After adjustment for sociodemographic factors, the near-miss rate per ride was lower at follow-up than at baseline (IRR = 0.77, 95% CI 0.60–0.99, p = 0.043), corresponding to an approximate 23% reduction. Victorian riders had lower near-miss rates per ride than those in Queensland (IRR = 0.58, 95% CI 0.36–0.95, p = 0.029). The crude near-miss rate per ride was higher among non-owners (21.2 vs. 15.8 per 1,000 rides) but this difference was not statistically significant after adjusting for sociodemographic factors. Sensitivity analyses varying the top-coding of ride frequency and near-miss counts yielded robust incidence rate ratios across all scenarios.

Benefits to road safety

To our knowledge, this is the first study to investigate how the safety of individual e-scooter riders changes with experience. By distinguishing between shared and private e-scooters, the study shows that risk patterns are not uniform across device types, underscoring the value of analysing micromobility with greater specificity rather than treating e-scooters as a single category. The observed geographic variation, including lower per-ride rates in Victoria than Queensland, further indicates that regulatory context and network design materially shape exposure to risk. By identifying an early-use window of elevated per-ride risk, distinct safety profiles for shared and private e-scooters, and meaningful differences across regulatory contexts, the research moves beyond describing incidents to specifying where action is most likely to reduce harm. The findings support evidence-informed collaboration between operators, governments, road safety communicators, and frontline responders to implement targeted, scalable measures that strengthen system-level safety outcomes.

Implications for policy and/or practice

The strong attribution of incidents to infrastructure implies a clear need for targeted infrastructure and e-scooter design improvements, including micromobility-specific reporting and rapid repair channels, as well as device changes such as larger wheels and front suspension. Since shared and private e-scooters show different incident profiles, prevention strategies should be differentiated: operator-led measures (onboarding, beginner modes, and device ergonomics) for shared fleets, and driver/pedestrian awareness campaigns to reduce conflicts where private e-scooters predominantly interact with other road users. The effectiveness of approaches aimed at quickly improving the safety of novice riders, such as mandatory or strongly encouraged short onboarding, app-based micro-training, and early-use nudges, should be carefully evaluated to guide policy responses. Importantly, policy should not treat ownership as a simple categorical exposure: private owners also ride shared e-scooters (Mansourifar et al., 2025), so interventions should target the device in use and the riding context rather than assuming mutually exclusive owner/non-owner groups. Finally, the lower per-ride risk observed in Victoria compared to Queensland suggests that regulatory environments and the physical riding network matter. This indicates that governments should prioritise segregated micromobility corridors, clearer riding-space delineation, and targeted treatments where e-scooters mix with pedestrians.

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However, these implications should be interpreted in the light of the study's limitations. Findings are based on self-reported data, limited crash counts, excluded jurisdictions, and missing location-type information for incidents. Self-report introduces the potential for recall error and subjective classification of events. For example, novice riders may interpret an event as a near-miss that more experienced riders would not. In addition, the exclusion of some jurisdictions limits regulatory variation in the sample. Accordingly, the results may not generalise to all Australian e-scooter populations or to jurisdictions operating under different riding rules.

Conclusions

Following the same riders over 12 months, near-miss rates per ride declined, suggesting experiential learning and adaptation reduce per-ride vulnerability. Shared and private e-scooters show different incident and attribution profiles, which implies distinct prevention levers for each device type. Immediate actions to trial and scale include operator onboarding and beginner ride modes, micromobility-focused infrastructure maintenance, and targeted local measures where e-scooter-vehicle conflicts are common. Future work should link self-reports to trip-level GPS or operator logs, capture precise incident locations and context, and extend panels beyond two waves to test durability of adaptation.

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DRAFT

Proactive road surface programme

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Abstract

Head-on and loss-of-control crashes are a significant contributor to road trauma, accounting for approximately 42% of fatal and serious injury crashes across the network between 2021 and 2025. A key contributing factor to these crash types, particularly loss-of-control crashes, is inadequate road surface friction. This project applied an evidence-led, proactive approach to address surface quality as a safety risk factor through two complementary components. First, a targeted resurfacing programme was developed using an economic prioritisation framework that integrated crash data, resurfacing history, and Sideways Force Coefficient Routine Investigation Machine (SCRIM) surface friction data. Second, a strategic network-wide analysis estimated the potential reductions in deaths and serious injuries associated with substantially improving surface quality. Geospatial analysis and visualisation tools were used to identify high-risk locations, coordinate resurfacing with other programmes, and support implementation. This work demonstrates how translating evidence into targeted maintenance action can deliver meaningful Safe System outcomes.

Background

Head-on and loss-of-control crashes are a major contributor to road trauma, accounting for approximately 42% of fatal and serious injury crashes across the network between 2021 and 2025. Given their disproportionate contribution to severe outcomes, it is essential that road safety approaches explicitly address these crash types.

A key contributing factor, particularly for loss-of-control crashes, is road surface friction, which is largely determined by surface condition and quality. As road surfaces deteriorate over time, friction levels reduce, increasing the likelihood of vehicles losing control and, in some cases, crossing centre lines and resulting in head-on crashes.

This project comprised two complementary components. The first developed a targeted resurfacing programme to address critical surface quality deficiencies using an economic prioritisation framework that combined crash data, resurfacing history, and SCRIM surface friction data. The second applied a strategic, network-wide analysis to estimate the potential reductions in deaths and serious injuries associated with substantially improving road surface quality.

Figure 1 Task and Solution

Conference theme

This evidence-led, data-driven approach brings together multiple data sources to identify road safety risks across the network. Rather than relying solely on historical crash data, it integrates road surface quality information to take a proactive approach to preventing future crashes before they occur. The approach is informed by established research demonstrating the relationship between surface friction, surface quality, and rates of deaths and serious injuries (Nicolosi et al., 2024).

Method

The project applied a structured geospatial analysis to identify road sections where poor surface quality contributes to elevated head-on and loss-of-control crash risk. Crash data from the NZTA Crash Analysis System were filtered to

include head-on and loss-of-control crashes only, and combined with carriageway and asset data, including SCRIM surface friction measures, resurfacing history, and surface material.

These datasets were integrated within a geospatial environment, where crashes were spatially joined to road segments and an economic evaluation framework was used to prioritise sections based on crash risk and surface condition. The output of this process was a targeted resurfacing programme, supported by quality-assurance checks and presented to the asset management team for implementation.

A supporting geospatial mapping system was developed to visualise results, overlay planned resurfacing with other projects, and support coordinated delivery and staging of works across the organisation.

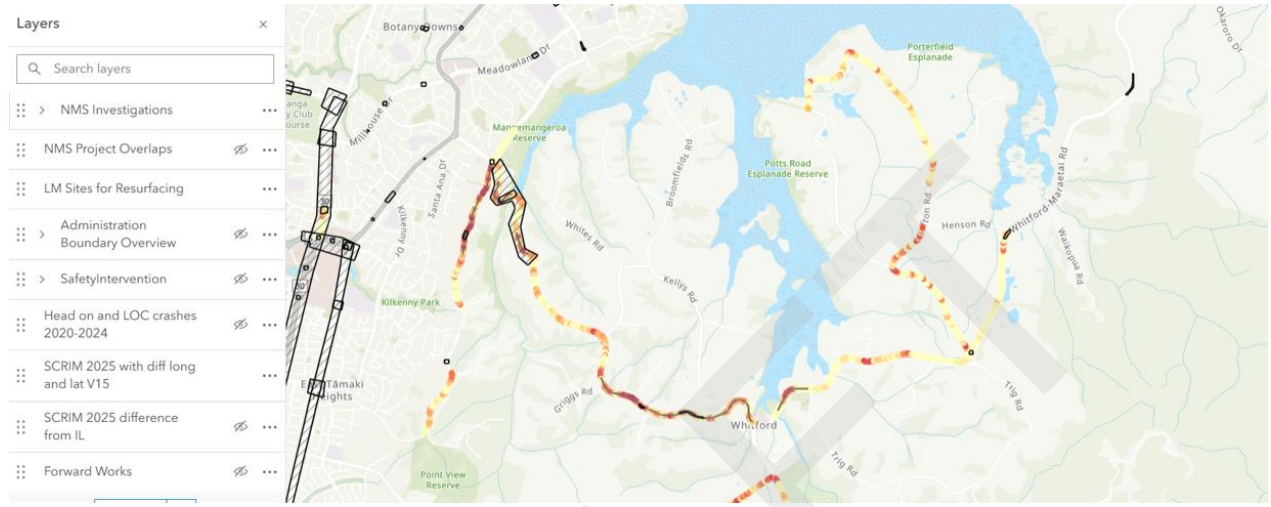

Figure 2 Supporting geospatial mapping system

Figure 3 demonstrates the alignment between proactive resurfacing with the safe system principles.

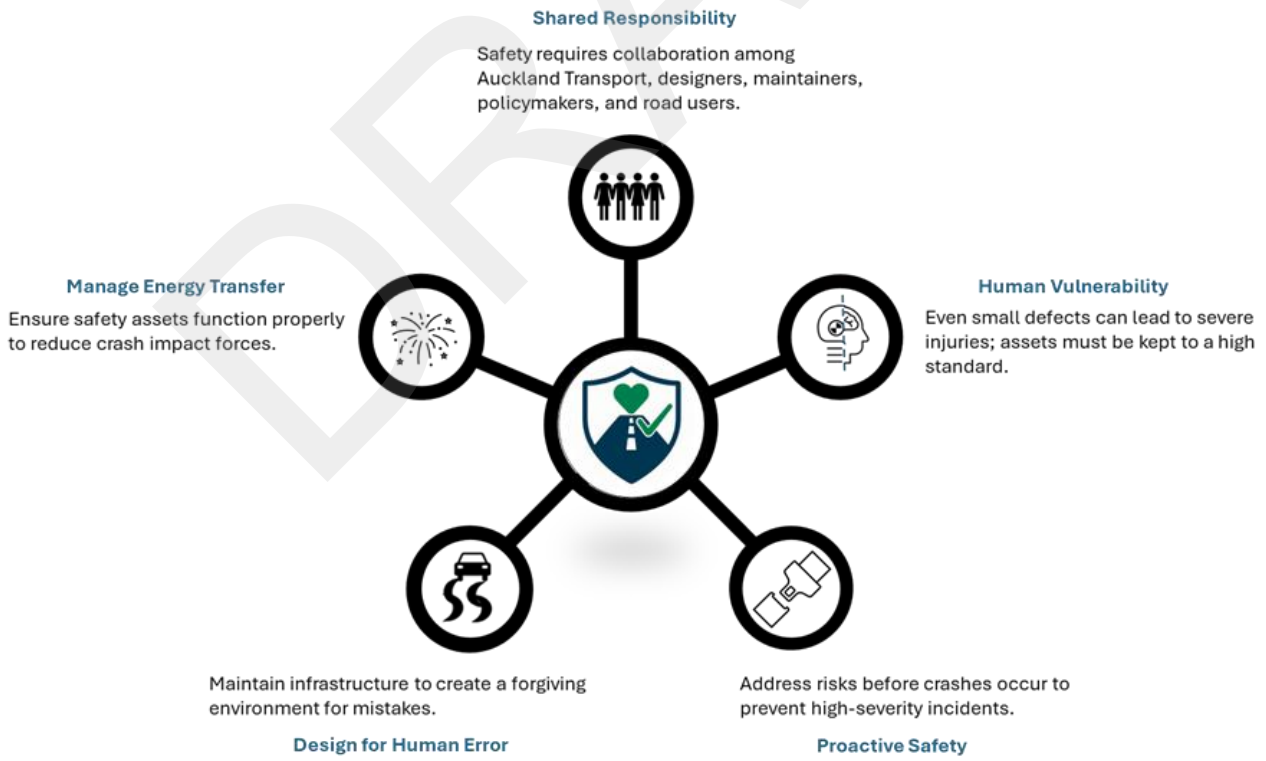

Figure 3 Alignment between proactive resurfacing with the safe system principles (Martin, 2025)

Figure 4 shows the step-by-step approach to this strategic analysis that looked at estimating the network wide ballot benefits of being able to address surface quality issues.

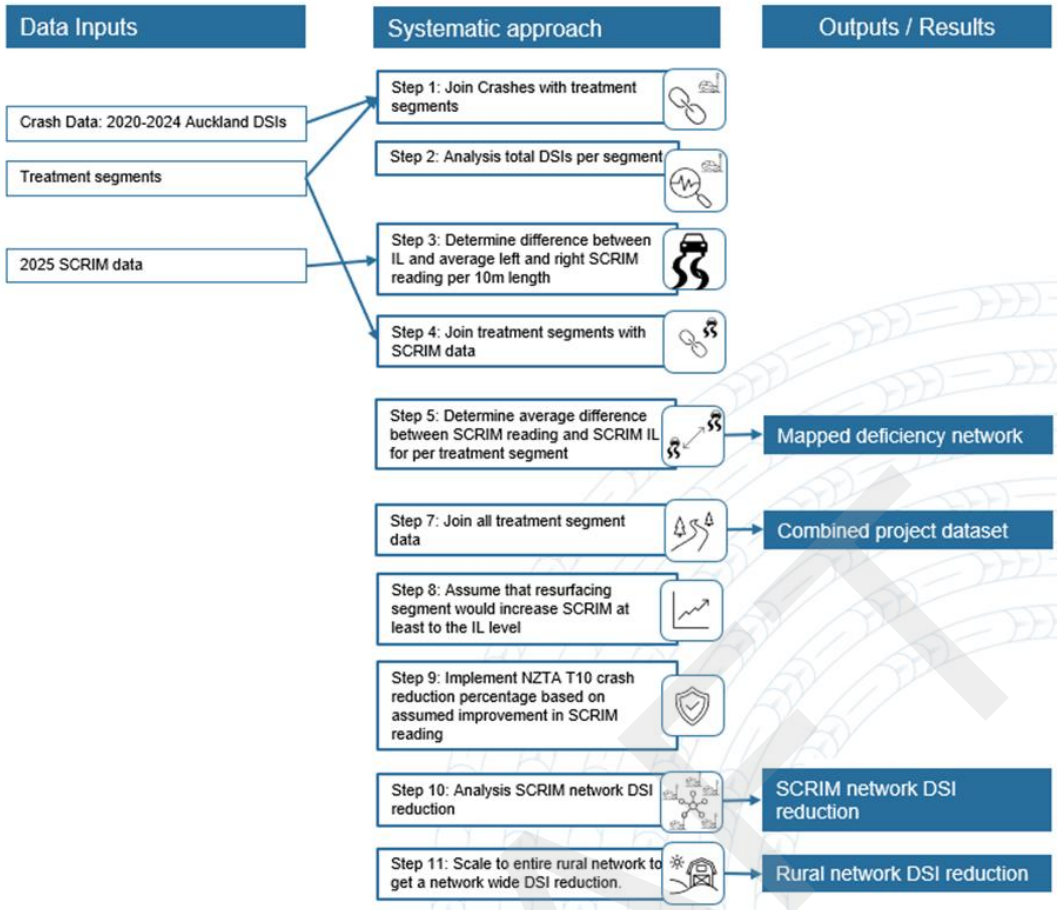

Figure 4 Strategic resurfacing process (Martin, 2025)

Results

Table 1 Results Table (Martin, 2025)

Scenario	Description	Estimated Reductions in head and loss of control FSI across the rural network
Scenario 1	Increase all SCRIM readings to at least the IL	11%
Scenario 2	Increase all SCRIM readings to at least the TL	5%
Scenario 3	Increase all SCRIM readings to the average SCRIM reading after resurfacing	18%

Implications for policy and/or practice

Incorporating this information into the Asset Management Plan supports policy and investment decisions that prioritise the reduction of deaths and serious injuries through the effective management of road surface quality across the network.

Conclusions

This analysis highlights the important role that maintenance plays in improving road safety outcomes. Modelling scenarios that improve SCRIM surface friction indicate that head-on and loss-of-control deaths and serious injuries could be reduced by up to 18% across the rural network, demonstrating the significant safety benefits of targeted maintenance interventions.

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Road meets rail: insights into technology and human factors impacts

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Abstract
The rate of near hits at Australian level crossings is trending upwards[1]. Despite this, few studies have investigated the use of safety cameras at level crossings or their effectiveness in influencing driver behaviour. At the 2024 National Level Crossing Safety Roundtable, Queensland committed to deliver the Queensland Level Crossing Safety Camera project. The project aimed to determine the level of unsafe behaviour at the road/rail interface, assess whether mobile camera technology could detect dangerous driving at enforcement standard, and evaluate the potential effectiveness of cameras in influencing driver behaviour. The project found a significant level of non-compliant behaviour at level crossings, particularly passive crossings. And while it found the technology did operate at a level suitable for camera enforcement, the human factors component indicated a need for further evidence. Overall, the project underscores the importance of integrating both technological and human factors considerations into safety solutions during pilot projects.

Background
There are approximately 1400 public level crossings over 10,000 kilometres of rail track in Queensland.
Level crossings enable road users to cross railway tracks but also pose significant safety risks and remain the leading cause of railway-related fatalities among the public. Managing safety at level crossings is a key concern for road authorities, rail managers, and communities. From 1 July 2020 to 30 June 2025, Queensland recorded a total of 49 collisions between road vehicles and trains at public level crossings, along with 814 near hits. Collisions increased between 2020 and 2025, with yearly averages of 1 fatality, 2 serious injuries, 10 collisions, and 163 near hits (Office of the National Rail Safety Regulator, n.d.). Collisions and near hits are caused by various factors, but direct causes are generally attributed to road users and their interactions with the crossing, with factors such as driver familiarity, driver misjudgement, inattention, and poor visibility identified in previous literature (Read et al., 2021). Level crossing incidents can result in severe injuries, property damage, service disruptions, and fatalities, with significant social and economic impacts on individuals, businesses, and communities. Even near misses (or 'near hits') can cause trauma, infrastructure damage, and road congestion, highlighting the critical need for improved safety measures.

At the 6 March 2024 National Level Crossing Safety Roundtable, the Director-General of the Queensland Department of Transport and Main Roads announced that a pilot of new-generation camera technology to detect road user non-compliance at level crossings would be led by Queensland, with learnings shared nationally. A proof of concept (POC) field trial of camera technology was undertaken, alongside a human factors study. Overall, the objectives of the project were to determine: the level of unsafe behaviour at the road/rail interface; if mobile camera technology could detect dangerous driving at level crossings at a standard required for potential future enforcement; and the potential effectiveness of camera technology for influencing driver behavior at level crossings.

Conference theme
The findings of the project contribute to the limited evidence-base regarding driver behaviour at level crossings with cameras in-situ and offer insights into the use of safety cameras to influence and or improve non-compliant driver behaviour. The findings will be used to help inform future regulatory decisions in this space.

Method
Sites for the field trial were selected by the Department of Transport and Main Roads (TMR) in consultation with the two main Queensland Rail Infrastructure Managers. The intention was to identify level crossings with highest safety risk. The Rail Infrastructure Managers provided a list of 35 (total) crossings which TMR prioritised based on type of crossing, traffic counts, incident reports, and infrastructure suitability. 12 active and 3 passive sites were selected as suitable, noting most passive sites had very low traffic or train movements which may have resulted in insufficient data.

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Four transportable trailer mounted cameras were deployed through the trial duration. The trailers were equipped with camera and radar technology to track and capture vehicles travelling bi-directionally through level crossings.

In 22 deployments (five sites had multiple surveillance periods) over 722 days, the trial generated 288,205 individual 'events'. At active level crossings, events were generated only when the crossing was considered active (signals flashing). Passive crossings (with stop signs) operate continuously. Traffic was monitored at all times, and all vehicle movements through the passive level crossings were recorded as events. The use of radar technology facilitated detection of vehicle behaviour based on speed analysis to determine if drivers stopped, slowed down but didn't stop, or failed to stop when signal activation occurred. For active sites, Artificial Intelligence (AI) was used to automatically detect when a signal was activated. For passive sites, combined radar and AI actively tracked vehicles as they approached the level crossing and prepared to stop (or otherwise). The outputs from the AI were all validated by a human review team.

The human factors study incorporated three phases: a literature scan to better understand the known prevalence of non-compliant behaviours at level crossings, effectiveness of camera-based enforcement systems in addressing this behaviour, and effectiveness of enforcement cameras in comparison to other level crossing safety interventions; the application of hierarchical task analysis (Kirwan & Ainsworth, 1992) to understand how enforcement cameras may influence behaviour at level crossings (both positively and negatively); and a subject matter expert (SME) survey, gaining input from 38 SMEs from a range of organisations including government transport agencies, rail companies, other transport operating companies, regulators, academic institutions and consulting organisations. An initial survey gathered expert opinions on the likely effectiveness of enforcement cameras in addressing non-compliant road user behaviour at level crossings, including comparative effectiveness with other safety measures, and a follow up survey summarised qualitative comments received into a set of principles and asked the SMEs to rate their agreement with the principles.

Findings

Field Trial

The technology captured non-compliance at enforcement quality. Of the 288,205 individual events recorded (204,787 at passive crossings and 83,41 at active crossings), 59,334 were identified as non-compliant incidents. Passive crossings accounted for 93.81% of all non-compliant incidents recorded.

The technology was able to record: The number of non-compliant incidents at each site (by category); the number of non-compliant incidents at active crossings as a proportion of level crossing activations; the number of non-compliant incidents at passive crossings as a proportion of vehicles entering the crossing; and recidivism rates (i.e. the number of repeat offending vehicles at each site; based on licence plate analysis). Key non-compliant behaviours included failure to stop (proceeding without significantly slowing), early departure (not remaining stationary during active crossings), and queueing/short stacking (vehicles stopping on/across the crossing). The field trial demonstrated that current camera technology can effectively detect dangerous or risk behaviours at level crossings, meeting equivalent evidentiary standards required for enforcement under TMR's camera-based enforcement program, such as those applied to camera-detected mobile phone and seatbelt infringements. Noting that while the camera video evidence may be sufficient, aadditional policing/evidentiary activities may be required to prove all elements of the offence.

Higher non-compliance at passive level crossings. The trial data indicated a significantly higher rate of non-compliance at passive level crossings: 55,661 compared to 3,673 incidents at active crossings.

Higher rate of repeat offending at passive level crossings. The trial data also identified a higher level of repeat non-compliance by the same vehicle (potentially the same driver) at passive level crossings, when monitoring cameras were present. The highest rate of non-compliant incidents assessed as repeat offences at passive crossings was 65%, compared to rate of 25% at active sites.

Human Factors Study

The literature scan identified little previous research into the effectiveness of camera enforcement programs at level crossings. While outcomes of some trials in other countries have been published, study quality is questionable, there have been few studies that compared enforcement cameras with other interventions, and some studies have conflicting results, especially in relation to cost-benefit analyses of camera programs. The findings of the hierarchical task analysis suggested that the implementation of enforcement cameras at level crossings may have positive or negative influences on behaviour and safety, dependent on the context. This suggests a site-specific approach needs to be adopted to account for individual features of each site and enable consideration of the specific benefits of introducing cameras and potential risks that need to be managed.

The survey results identified that experts generally had mixed views regarding the effectiveness of enforcement cameras for addressing non-compliant behaviours at level crossings, and the extent to which cameras would be effective for

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different road user groups. Experts suggested that to be effective, a camera program would need to create a reasonably high belief in a road user that they are likely to be detected for non-compliance (average rating of 65% likelihood of detection). Although not commented on specifically by the experts, with around 1,400 public level crossings in Queensland, it would likely require a significant program to be in place to achieve this level of belief of likelihood of detection. The majority of experts agreed on the following principles regarding risk management at level crossings: changes to infrastructure or warning type at a crossing (e.g. installation of active warnings) should be prioritised above the introduction of camera systems; safety interventions at level crossings should be considered at a broad system level; and a suite of interventions are required to address different motivations or contributory factors underpinning non-compliant behaviours at level crossings. The majority of experts agreed with additional principles regarding the design and implementation of level crossing camera enforcement programs, including: camera enforcement should target unambiguous non-compliant behaviours; road users need to believe there is a high likelihood of detection; consequences for non-compliant behaviors need to be significant (i.e. severe); and camera implementation should consider the potential for introduced risks.

Benefits to road safety

Level crossings are a necessary component of many road networks. While incidents at these locations are relatively infrequent compared to the broader road network, their consequences are severe, often involving serious injuries or fatalities. As population growth and increasing traffic volumes lead to greater interaction between road users and rail networks, understanding driver behaviour and the impact of regulatory interventions at the road-rail interface is increasingly important. This study contributes valuable insights to the limited evidence in this area, advancing the findings of existing research by undertaking a contemporary technological trial and combining the technical findings with likely impacts on road user behaviour within a single project.

Implications for policy and/or practice

The field trial data, combined with the available evidence on the effectiveness of camera enforcement in a level crossing environment, indicates there is no single solution to achieve compliant driving behaviour at level crossings. Instead, the findings highlight the need for a coordinated, multi-faceted approach to address the complex safety challenges posed by this infrastructure. The project is currently in policy-making phase and a prioritisation framework being developed to inform future policy decisions.

Results from both the field trial and the human factors study support the position that any policy aimed at reducing non-compliance at level crossings should be integrated into a broader strategy. This strategy must target the diverse range of factors contributing to non-compliance, including both deliberate and unintentional behaviours. Potential solutions may include infrastructure upgrades, targeted enforcement initiatives, public education and awareness campaigns, and advanced in in-vehicle technology. Additionally, the findings of the study findings emphasise the importance of adopting a system-wide approach to risk and benefit assessment, rather than relying solely on site-specific practices. Such an approach ensures that policies are comprehensive, scalable, and adaptable to varying contexts.

Limitations

It should be noted there were some limitations to the trial methodology that may affect the interpretation of findings. The site selection process focused on high-risk crossings, which, while practical for targeting areas of greatest need, introduced a site selection bias that may limit applicability to lower-risk sites. The absence of a comparative study design (with control sites and including enforcement mechanisms) limited the ability to assess behaviour change, as deterrence effects were unable to be measured. Finally, the subject matter expert survey was constrained by limited sample diversity, potentially reducing diversity of perspectives.

Conclusions

The field trial demonstrated that current camera technology can effectively detect non-compliance at level crossings, meeting enforcement standards. The project illustrates the benefits of combining technology trials with human factors analyses. Overall, the project identified limited evidence of the impact of cameras in level crossing environments, including their ability to improve safety, change driver behavior, or influence public perception. To build evidence for robust safety solutions in this area, future studies should test camera programs which incorporate consequences (e.g. infringements) and explore integrated strategies combining enforcement with other measures to address non-compliant driver behaviour.

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Keeping people safe when walking – improving guidance

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Abstract
This paper presents an overview of key areas where improvements can be made in pedestrian safety guidance, including gaps in existing standards, guidelines, and methodologies. It explores opportunities to strengthen a systems-based approach to pedestrian safety planning, intervention selection, and evaluation. Through a combination of literature review and stakeholder engagement, this work identifies challenges practitioners face and highlights potential enhancements to national guidance. The findings presented in this paper will contribute to the ongoing evolution of pedestrian safety practices, informing future updates to relevant transport policies and standards.

Introduction
The Austroads project SAG6371 Keeping People Safe When Walking is being undertaken over three streams as depicted below.

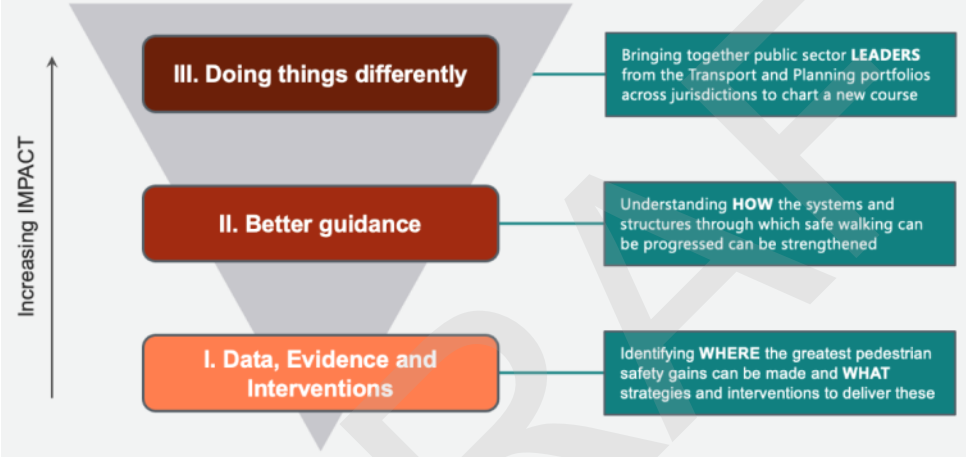

Figure 1. SAG6371 Streams

This project fits within Stream 2 ‘Better Guidance’. The focus of the Work Package is to support Austroads members’ pedestrian safety practice, through better transport guidance, approaches and methodologies. The overarching principle guiding this project has been to establish, document and analyse how practitioners across Australia and New Zealand develop pedestrian safety solutions. Investigating the gaps, inconsistencies and barriers practitioners face has enabled this project to recommend relevant, tangible changes to Austroads publications (and other resources).

The stakeholder engagement and literature review uncovered that jurisdictional supplements often offer improved pedestrian safety outcomes compared to the national standards / guidelines. To this end, to improve the safety of people walking there is appreciable evidence to update national guidance, approaches and methodologies. This evidence is further supported by the work completed in Stream 1.

The evidence is clear: Despite knowing how to make our roads and streets safe for pedestrians, especially the most vulnerable cohorts – children, the elderly, those with limited ability and First Nations people – Australia and New Zealand lag and pedestrian safety is only marginally improving. We must accelerate the adoption of life saving pedestrian safety measures. (Austroads, 2025)

Conference theme
This project strongly aligns with the Australasian Road Safety Conference 2026 theme, “*From Evidence to Action: Shaping a Brighter Future*” by translating pedestrian safety evidence into practical, system-level guidance that supports implementation by practitioners and decision-makers. The report synthesises Australasian and international research, Austroads guidance, and practitioner experience to identify where existing pedestrian safety guidance is insufficient, inconsistent, or misaligned with Safe System principles. It then moves beyond problem definition by providing targeted, action-oriented recommendations to strengthen planning, design, evaluation, and monitoring of pedestrian safety interventions.

Method

There were two key methodologies employed to investigate, document and analyse pedestrian safety practices across Australia and New Zealand described below.

Literature Review

The literature review methodology was developed with a practitioner-focussed approach. In total, over 100 publications were analysed as part of the literature review. The predominant sources of literature were Austroads publications and guidelines from Australasian jurisdictions. The sources of the literature reviewed have been broadly categorised into the headings shown in Figure 2. The literature review focussed on reflecting on Austroads current publications, investigating stakeholder practices and examining pertinent Austroads research reports. This approach led to a comprehensive understanding of how practitioners currently reference guidelines when developing pedestrian safety solutions and embed insights from recent Austroads projects.

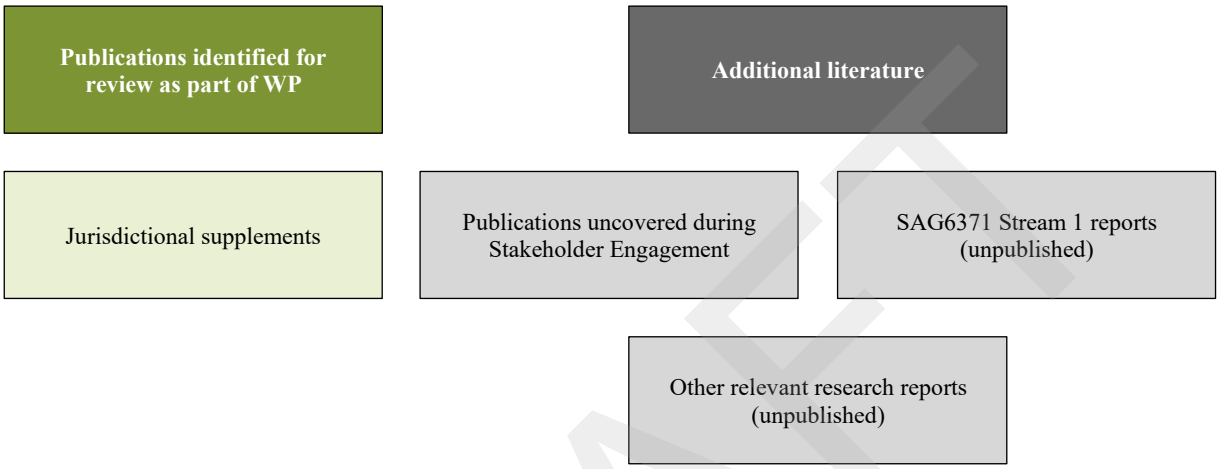

Figure 2. Literature review methodology

Jurisdictional supplements were reviewed where applicable. Several jurisdictions across Australasia offer their own supplements to the aforementioned Austroads publications. The purpose of the supplements is to provide additional context (for instance referring to specific jurisdictional strategies, policies and guidelines) and also articulate any changes (departures) from the Austroads publications. Practitioners commonly refer to both the Austroads publications and the jurisdictional supplement document – with the latter taking precedence where there are discrepancies in guidance. Including the review of jurisdictional supplements provided greater insight into current practices across Australasia.

Stakeholder engagement

The overarching objective for undertaking stakeholder engagement was to identify successful and effective strategies, practices, or approaches within the field of pedestrian safety. Key to achieving this goal was engaging with practitioners and subject matter experts. There were multiple avenues for engagement including workshops, online surveys and one-on-one interviews.

The focus of the stakeholder engagement process was to understand any risks, challenges, barriers, and lessons learned that road managers or government agencies have encountered, as well as the measures taken to overcome these challenges. These included institutional (including policy) barriers, as well as political and community opposition to implementing the desired changes.

The outcome of this process unveiled considered, pertinent and practitioner-derived gaps and opportunities within the field of pedestrian safety.

Report

This project has culminated in the development of the Austroads Research Report AP-R756-26. This report has been through several iterations of peer review. Reviewers have included the Project Control Group (PCG), Expert Working Group (EWG), Austroads Task Forces and Austroads Board. The feedback from technical and subject matter experts has been pivotal in developing this report.

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Findings

The findings of this project have not been detailed in this abstract. Over 100 unique recommendations were made in this project. At a high-level, some of the key themes that have emerged from this project include:

- highlighting the relationship between vehicle impact speed and the human body's tolerance to forces;
- summarising what pedestrian demographics are over-represented;
- exploring how pedestrian demographics may influence design choices;
- strengthening the case for raised pedestrian crossing points;
- updating the minimum accepted footpaths widths;
- altering the methodology of defining footpaths;
- ensuring pedestrians are considered during Road Safety Auditing; and
- acknowledging safety risks for pedestrians at roundabouts.

The findings from this project offer a step towards our vision of seeing zero harm on our transport network and a more accessible, equitable space for our communities. This project emphasises the need to view our transport network through a human lens and not a vehicle lens.

Benefits to road safety

The focus of this project is improving the safety for people walking. The recommendations as part of this project provide practitioners enhanced guidance, tools and methodologies to help them plan, design and evaluate safe pedestrian treatments. The benefits to road safety are unequivocal.

Implications for policy and/or practice

The recommendations as part of this project will be considered and enacted into Austroads publications over time. There is not a single, set date for all publications to be updated based on this project, instead each publication will be revised gradually. The major changes would occur within the Austroads Guide to Road Design Set, Austroads Guide to Road Safety Set and Austroads Guide to Traffic Management Set.

Conclusions

This project has culminated in the development of the Austroads Research Report AP-R756-26. This report and an associated webinar is publicly available to view (link). This report identifies gaps in the current pedestrian safety literature and provides recommendations to address these areas. Some key recommendations include:

- strengthening guidance around raised pedestrian crossing points;
- providing tangible examples of designing for different demographics;
- centering transport planning and design from a human lens; and
- recognising how speed management can significantly reduce pedestrian crash risk.

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An online intervention to improve older adult pedestrian safety

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Abstract
Older adults represent a disproportionate number of pedestrian crash fatalities, indicating a need for intervention to improve their safety. People Crossing Safely is an online training program that has been designed to improve predictors of pedestrian safety, namely cognitive capacity, physical capacity, and road crossing skill. While full evaluation of People Crossing Safely is anticipated to be completed in August 2026, data from a single participant who has completed the 4-week training program is reported here. Throughout training, the participant improved their road crossing skill and their performance on all three cognitive capacity measures. The participant was able to complete more challenging physical exercises post-training, but it is unclear if overall physical capacity was improved. Preliminary evidence suggests online training program has potential to improve the safety of older adult pedestrians.

Introduction
Although older adults account for ~18% of the population, they make up ~40% of pedestrian crash fatalities (Bureau of Infrastructure and Transport Research Economics [BITRE], 2019). Although older age is a predictor of risk for pedestrians, there is a need to consider the full range of factors that contribute to pedestrian safety, such as cognitive and physical decline, and street crossing behaviour (Carrigan et al., 2026). Cognitive functions that have been shown to be relevant for safe road crossing include visual search, inhibitory control, and working memory (Carrigan et al., 2026; Valos & Bennett, 2023). Physically, factors such as walking speed, mobility, and balance are important for safe road crossing (Carrigan et al., 2026).

Safe road crossing itself has been conceptualized in three stages; an initial approach to the roadway (stage 1), the initiation of crossing (stage 2), and completion of the crossing (stage 3; Carrigan et al., 2025). Pedestrian literature tends to focus on the second stage, as this stage includes the identification, interpretation, and response to hazards (i.e., hazard perception (HP); Horswill et al., 2009), and the judgement of whether there is a sufficient gap in the traffic to cross safely (gap acceptance (GA); Oxley et al., 2005). Compared to younger adults, older adults have poorer HP and GA skill, and therefore improvement in these skills is the focus of training interventions.

A recent systematic review of training interventions for older adult pedestrians supports that training can be effective, however, the evidence is limited (Blanks et al., 2024). Only eight studies have implemented training interventions for older adult pedestrians, and improvement was only shown in 30.5% of behavioural outcomes, 14% of cognitive outcomes, and 50% of physical outcomes. The review recommends that future interventions should be informed by theory to better target factors that are known to be relevant for safe pedestrian behaviour (Blanks et al., 2024).

Development of People Crossing Safely
Over the course of this project, multiple stages have been completed to develop an online training intervention that focuses on cognitive capacity, physical capacity, and street crossing ability. Stage One established the feasibility of measuring pedestrian HP and GA using a virtual reality test. The Virtual Reality Pedestrian Street Crossing Task (VR-PSCT) was developed and validated to assess these behaviours in children and adults (Bennett et al., 2025). In Stage Two, 100 participants aged 60-83 years were tested to determine which visual perceptual, cognitive, and physical factors best predict safe pedestrian behaviour (Carrigan et al., 2026).

Findings from Stage Two informed Stage Three, which involved the development of the online training intervention for older pedestrians called People Crossing Safely. Throughout the development of People Crossing Safely, usability testing established the feasibility of the online training for older adults. The final training program includes 16 individual sessions to be completed over a 4-week period. Each 45-minute session includes a 15-minute module focusing on street crossing behaviour, cognitive capacity, and physical capacity. The street crossing behaviour modules focus on common factors that influence the ability to make safe crossing decisions, such as hazard perception, visual clutter, visual exploration of the roadway, and safe road infrastructure. The street crossing behaviour module also includes within-session pre-post testing of street crossing skill using simulated street crossing tasks. The cognitive training modules focus on visual search, inhibitory control, and working memory. Each task was developed as a modified ‘roadway-relevant’ version of a standardized cognitive assessment. The physical training modules focus on

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developing mobility and strength, with eight primary exercises and three difficulty levels for each exercise. The training is accessible via a computer browser and can be completed at home with minimal resources.

Aim
To investigate preliminary single user performance on the street crossing behaviour, cognitive capacity, and physical capacity training modules of the People Crossing Safely online training program.

Conference theme
This program of work is firmly focussed on putting evidence into action. We have used evidence to develop an online training program for older pedestrians, and following thorough evaluation, the training program will be made publicly available. It is intended that this action will help improve the safety of older pedestrians.

Method

Participants
Data collection for this study is ongoing. Here, data is reported for a single participant who has completed all training sessions of the People Crossing Safely online training program. The participant is a 70-year-old male from NSW.

Training Protocol
The full intervention began February 2026 and will conclude in August 2026. Data reported here is preliminary within-session data from a single participant. The participant completed laboratory-based pre-training testing of their visual perception (visual acuity and contrast sensitivity), cognitive performance (visual search, inhibitory control, and working memory), physical performance (walking speed, mobility, lower body strength, and balance), road crossing skill (hazard perception and gap acceptance), and driving skill (hazard perception and gap acceptance). The participant completed the whole 16 session People Crossing Safely online training program over a 4-week period. One week after the 4-week training intervention, the participant completed laboratory-based post-training testing, however, post-training laboratory testing data is not yet available, therefore within-training data is reported here.

Outcomes
For road crossing skill, the first and last street crossing behaviour sessions are used for pre-post measurement, with the number of safe crossing decisions out of 11 trials measured. For cognitive training, the first three and last three sessions are used as pre-post measurement for visual search, inhibitory control, and working memory, with two outcomes for each measured. For physical training, the first and last sessions are used as pre-post measurement, with eight strength and mobility exercises measured.

Results
For gap acceptance performance, the participant correctly responded for 9/11 trials in the pre-test (i.e., in their first session) and correctly responded for 11/11 trials in the post-test (i.e., in their last session). Cognitive performance is reported in Table 1. The participant improved their performance on all indicators of cognitive performance from pre-to-post training, with the exception of mean response time for working memory. However, the cognitive task used is a variation on the corsi block task, whereby the task gets progressively more difficult with longer spans. Given the participant increased their span from 2 to 4 blocks, it is reasonable to expect the mean response time between each block to also increase.

Table 1. Within-training cognitive performance change from pre to post training

Cognitive outcome	Pre*	Post*
Working memory – overall span	2	4
Working memory – mean response time (sec)	0.66 (0.53)	1.17 (0.85)
Visual search – number of trials presented	53	72
Visual search – mean response time (sec)	5.04 (5.13)	4.39 (8.34)
Inhibitory control – correct NoGo (out of 32)	27	28
Inhibitory control – mean response time (sec)	0.46 (0.21)	0.43 (0.20)

* Values shown are count or mean (SD).

Physical performance is reported in Table 2. For the first three exercises, the participant increased the task difficulty from level 1 to level 2. While the number of reps was reduced, the increase in difficulty represents an improvement in performance from pre-to-post training. For the rest of the exercises (lunges to step taps), the participant had reduced performance from pre-to-post training. However, it is possible that this is due to fatigue from the increased difficulty of the first three exercises.

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Table 2. Within-training physical performance change from pre to post training

Exercise	Pre*	Post*
Sit to stand	12 (1)	12 (2)
Calf raise	28 (1)	25 (2)
Hip flexion	26 (1)	24 (2)
Lunges	16 (1)	15 (1)
Figure 8's	9 (1)	7 (1)
Side steps	9 (1)	7 (1)
Step overs	8 (1)	8 (1)
Step taps	22 (1)	16 (1)

* Values shown are number of reps (difficulty level). Exercises were performed in the order presented.

Benefits to road safety

This work has direct benefits to the road safety of older adult pedestrians. The intervention being assessed by this work will be made publicly available at the conclusion of the project. This intervention will be freely available and accessible online for people to complete the training themselves, at home. It is anticipated that for those that take advantage of this opportunity, their safety as pedestrians will be greatly improved.

Implications for policy and/or practice

Cognitive capacity, physical capacity, and road crossing skill are all predictors of safe pedestrian behaviour. Based on the single participant reported here, it appears that a 4-week online training intervention can improve all three of these predictors of safe pedestrian behaviour. While evidence from a larger sample is needed, the provision of accessible training programs for older adults is important for improving older adult pedestrian safety.

Conclusions

The People Crossing Safely 4-week online training program shows promise for improving older adult pedestrian safety. Full evaluation of the program is currently underway, with testing expected to be completed in August 2026. Following evaluation, it is expected that the program will be made freely available for public use.

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Parliamentary Inquiry: Queensland's e-scooter safety evidence from research to policy

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Abstract
Regulation has struggled to keep pace with the rapid uptake of e-scooters. This study examines how safety evidence moves through policy and into action in relation to the 2025 Parliamentary Inquiry into e-Mobility Safety and Use in Queensland. Drawing on a systematic review (168 studies), a survey of 461 Queensland riders, and real-world behavioural observations, we submitted 13 evidence-based recommendations to the Inquiry. Following the release of the Inquiry's 28 recommendations (February 2026), we mapped our evidence against the report to assess alignment between research findings and policy outcomes. The Inquiry marks an important step toward updating Queensland's e-mobility framework, but translating recommendations into effective safety improvements requires refinement. Our findings suggest that reforms recognising differences in devices, rider behaviour, and ownership types are more likely to improve safety than approaches treating riders under a single regulatory model. The study also examines whether post-Inquiry actions align with the evidence-based priorities.

Introduction
E-scooters are now widely recognised as part of the urban transport landscape. When used safely and responsibly, these devices offer clear benefits, providing a convenient and affordable option for short trips, reducing reliance on private cars, and contributing to environmental sustainability. However, their rapid growth has also raised significant safety concerns. As e-scooter use has increased, injury presentations and public concern have risen alongside it. The presence of illegal or non-compliant devices on public roads, together with ongoing enforcement challenges, has further complicated the issue. Injury data from the Queensland Injury Surveillance Unit (QISU) shows an increase in personal mobility device (PMD) injuries, predominantly e-scooters, from 1,626 cases in 2024 (136 per month) to 2,000 cases in 2025 (167 per month) (QISU Data, 2026). More concerning, Queensland accounts for roughly one-third of all media-reported e-scooter deaths nationally, and half of the deaths involving riders under 16 (Metro North Health, Feb 2026). In May 2025, the Queensland Parliament launched an Inquiry into e-mobility safety to address rising crashes, injuries and fatalities; powers to enforce dangerous riding; and gaps in the law allowing illegal devices to be imported and used.

Most PMD discussions have been impeded by a lack of reliable data or have focused on the devices themselves and technical solutions, with comparatively little attention given to rider behaviour. Yet many severe injuries are linked to risky behaviours such as not wearing a helmet, speeding, riding in prohibited areas, and riding under the influence of alcohol (ITF, 2024). Where rider behaviour has been studied, the focus has been predominantly on shared e-scooter schemes, largely because higher rates of non-compliance have been reported among shared users than private riders (Haworth et al., 2021; Roberts et al., 2025). But that leaves a massive blind spot, particularly as recent injury surveillance data show that serious harm is not confined to one ownership type. Jamieson Trauma Institute interview data show that 64% of injuries involved private e-scooters, compared with 36% involving shared scooters (Jamieson Trauma Institute, December 2024). The findings also suggest that ownership-related risk does not operate uniformly. For example, 79% of injured private riders reported wearing a helmet, compared with 50% of shared users, while alcohol consumption before riding was substantially higher among shared users (35%) than private users (7%). At the same time, private riders appear more likely to engage in speed-related risk, with more than one-third of injured riders reporting speeds above the legal limit of 25 km/h.

These findings add complexity to the current safety debate and raise an important policy question: can a regulatory framework that treats all riders the same effectively ensure safe use across different rider groups? Our study provides answers by drawing on one of the most comprehensive datasets currently available on e-scooter rider behaviour in Queensland. We examine how riders differ, how their behaviour changes across different riding contexts and ownership types, and what factors influence risk-taking and compliance. The recommendations from this study aim to inform amendments to Queensland's PMD framework to recognise differences in rider behaviour and translate these insights into targeted education, evidence-based policy, and enforcement strategies.

Conference theme
This study directly addresses the conference theme From Evidence to Action by tracing how behavioural safety research can inform real-world regulatory decisions. Using empirical evidence on e-scooter rider behaviour, compliance patterns, and risk perception, the study translated these findings into evidence-based recommendations submitted to the Queensland Parliamentary Inquiry into e-mobility safety. The research then evaluates how these recommendations were

reflected in the Inquiry's final report and whether they are likely to translate into effective safety interventions. By tracing the pathway from empirical evidence to policy recommendations and potential implementation, the study demonstrates how research can inform regulatory reform, shape public debate, and support decision-makers in responding to emerging transport safety challenges.

Project description

We conducted one of the most comprehensive behavioural studies of e-scooter use in Australia, drawing on both international evidence and original empirical data from Queensland. First, we conducted a peer-reviewed systematic review of 168 studies on e-scooter usage, safety risks, and regulatory responses to identify established international practices. Second, we collected original empirical data from a survey of 461 e-scooter riders across Queensland. The survey collected data on riders' awareness of existing rules, self-reported compliance, reasons for non-compliance, and safety-related outcomes, including crash experiences and penalties issued by police. The analysis examined whether these behaviours vary across rider groups defined by ownership type (shared or private), demographic characteristics, riding experience, and trip purpose. This enabled the study to identify differences in behavioural patterns and risk-related practices across rider groups. To complement the self-reported data, we also observed rider behaviour in real-world settings to assess whether reported behaviours aligned with observed practices.

Based on these findings, 13 evidence-based recommendations were submitted to the 2025 Queensland Parliamentary Inquiry. The Inquiry's final report, released in February 2026, presented 28 committee recommendations drawn from more than 1,200 submissions and evidence from over 140 witnesses across the state, including the authors of this study. Following publication of the Inquiry outcome, we undertook a structured mapping exercise to position our evidence within the broader inquiry process.

The final stage of this research evaluated the extent to which the safety issues identified in our study, and the broader concerns raised across public submissions, are reflected in the Committee's recommendations. It also assessed whether these recommendations meaningfully address the key behavioural risks identified in the evidence, and whether they are likely to produce measurable safety improvements if implemented. In addition, the presentation will examine post-inquiry responses to determine the extent to which the Committee's recommendations have translated into policy actions and regulatory interventions.

Findings

The Inquiry report has recommended new restrictions in Queensland on e-mobility devices such as e-bikes and e-scooters (Queensland Parliament Committee, 2026).

Examples of where the Inquiry recommendations are supported by empirical evidence

Several aspects of the Inquiry report align well with the available evidence. It recognises that e-mobility is here to stay and that we need sensible rules, not bans. It captures real community concerns about illegal high-powered devices entering the market, missing infrastructure, weak rule communication, and enforcement that is patchy at best. Crucially, several of the proposed reforms align closely with the behavioural evidence presented in our submission, for example: Minimum age (Recommendation 13): Raising the minimum riding age to 16 and requiring riders to complete the PrepL road rules online learning program. Our research suggests Queensland's two-tier age framework (16 for unsupervised riding, 12-15 with adult supervision) unintentionally contributed to underage riding and risky practices such as double riding.

Risk perception (Recommendation 8, 27, 28): Our research shows that riders' non-compliance was largely influenced by "low-risk perception" and "lack of support for the law", both of which can be improved through targeted educational material. Riders tend to adjust their behaviour according to perceived risk rather than behave consistently across situations. Children often lack the experience and situational awareness needed to judge traffic risks, also supporting the need for clearer minimum age requirements.

Simplifying rules and improving signage (Recommendation 11, 17, 21, 27, 28): Our research shows confusion about rules was a predominant driver of unintentional non-compliance. Simpler, more visible, and more consistent rules, supported by clear street-level signage and wayfinding, can support riders in making safer decisions in real time.

Examples of where the Inquiry recommendations are not supported by empirical evidence

The Inquiry largely treats e-mobility devices under a single regulatory umbrella. This overlooks important differences between devices such as e-bikes and e-scooters, as well as differences between privately owned and shared fleet devices. Our research shows these differences shape how riders interact with the road environment and how risks emerge in practice.

The issue becomes particularly visible in Recommendation 12 of the report, which proposes a two-tier regulatory system. Under this model, devices capable of exceeding 25 km/h would be reclassified as motorcycles or mopeds and restricted to road use only. Riders would be required to hold an appropriate class of driver licence (e.g., a motorcycle

licence), register the vehicle, obtain compulsory third-party insurance, have a vehicle identification number (VIN), and wear a motorcycle helmet. Importantly, most of the devices currently in use and being imported would not meet the standards for reclassification and would become themselves illegal to use (Department of Transport and Main Road, 2026). Moreover, non-compliant devices can already be sold if intended for "private property only." Recommendation 19 would require such devices to be marked as "for use on private property only" to discourage their use in public spaces. However, the enforcement pathway remains unclear. Without clear responsibility at the import, retail, or compliance stages, this approach risks shifting accountability between actors, while in practice the recommendations do not address removing these illegal devices from circulation or managing the transition for existing owners who have purchased them, often at considerable cost. While the report recommends supporting enforcement by police (Recommendation 22, 23, 24, 25, 26), there is little consideration of the practical capacity for enforcement, particularly given current resource constraints. As a result, many of these devices are likely to remain in use despite being technically illegal, potentially perpetuating the very safety risks the regulatory changes seek to address.

Benefits to road safety

This research contributes to road safety by identifying the behavioural mechanisms that underpin risk in e-scooter use and demonstrating how these mechanisms can inform targeted regulatory responses. By combining international evidence, rider survey data, and real-world behavioural observations, the study provides one of the most comprehensive behavioural analyses of e-scooter use in Queensland. The findings highlight how differences in rider experience, ownership type, and risk perception influence compliance and crash risk. Mapping these behavioural insights against the Inquiry's recommendations helps identify where proposed reforms are likely to reduce injuries and where additional refinement may be needed. In doing so, the research supports the development of proportionate, evidence-based interventions aimed at reducing serious injuries while preserving the mobility benefits of emerging transport technologies.

Implications for policy and/or practice

This research helps ensure reforms are proportionate, enforceable, and focused on the highest-yield risk mechanisms rather than adopting a single solution for diverse e-mobility modes. Our findings support a refinement pathway that optimises recommendations before they become law, ensuring the effort of regulatory change actually delivers the safety outcomes we intend.

Conclusions

Regulating e-mobility is complex, and there is no quick or single solution that can immediately eliminate safety risks. In the short term, priority should be given to stopping more unsafe devices from entering the market and ensuring riders follow the rules on the devices already in use by clear communication, reducing confusion on the road, and reinforcing them through consistent enforcement. At the same time, while the Inquiry addresses many safety concerns, several contested areas remain, particularly where proposals risk a one-size-fits-all approach, highlighting the need for more targeted and context-sensitive rule refinement in the next phase of reform.

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DRAFT

Optimising fixed automated road safety enforcement for Victoria

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Abstract

Automated enforcement has been used in Victoria since 1983 and expanded steadily over time. Previous research focused on evaluating safety outcomes, with limited attention to factors influencing safety camera differential effectiveness. This research developed and tested a proactive, evidence-based methodology for FDSRLCs site selection, challenging traditional crash-history-based approaches to enforcement deployment by examining how road characteristics, identified through literature review, influence enforcement effectiveness. A before-and-after quasi-experimental design using Poisson regression models estimated crash reduction associated with FDSRLCs and assess its differential effectiveness across site characteristics. The analysis explored relationships between intersection characteristics and camera performance to determine the conditions under which enforcement is most effective. Results showed that FDSRLCs achieve greater safety benefits at intersections with narrower road widths, medium to high traffic volumes, simpler geometric design, and higher infringement rates. These findings supported the development of a practical prioritisation methodology to improve and optimise camera site selection.

Introduction

Research has extensively examined the relationship between speed and crash and injury risk. High driving speeds are associated with a higher crash rate and with a greater likelihood of more severe outcomes (Aarts & Van Schagen, 2006). Automated speed enforcement has been deployed to ensure better adherence to speed limits and therefore improved road safety. It is widely accepted that appropriate speed limits and their enforcement are effective road safety measures (Elvik et al., 2019). Automated enforcement has been used on Victorian roads since 1983, with the introduction of the red-light camera program at signalized intersections. Since then, the camera program has grown to include fixed spot and point-to-point speed cameras, combined speed and red light cameras, and mobile speed cameras (Pearson, 2011).

Previous studies have focused on evaluating the road safety outcomes of speed enforcement technologies. Research showed that speed cameras reduce motor vehicle speeds and crashes by affecting positive behaviour change through general and specific deterrence (Cameron & Delaney, 2008). Moreover, fixed cameras were found to be an effective way to manage driver behaviour and thereby improve road safety (Kloeden et al., 2019). However, no previous research has examined broadly the rationale and limitations of camera deployment, including the criteria by which sites are selected for camera placement, limitations in site selection, and the measures required to overcome them. One of the major limitations of speed camera deployment is the absence of clear site selection guidelines for fixed camera placement based on scientific evidence. Although there is no definitive best practice for selecting safety camera locations in the literature, frequently used criteria mostly rely on crash data.

As part of its 2006 performance audit, Making Travel Safer: Victoria's speed enforcement program, the Victorian Auditor-General's Office (VAGO) found that guidelines for selecting fixed camera sites were insufficiently justified and it recommended that more detailed site selection criteria be developed. In his audit report, Pearson (2011) mentioned that determining the location for fixed speed cameras was the responsibility of Victoria Police and the other Victorian road safety agencies. In its speed camera site selection criteria document (Speed camera site selection criteria, 2006), Victoria Police stated broadly that site selection for fixed cameras should consider traffic volume and whether the risk of high trauma at the site was speed related. In response, in 2007 Victoria Police and the then-Department of Justice (DoJ) established the Fixed Camera Site Selection Committee (the Committee) to address the VAGO recommendations. The Committee's terms of reference included developing and implementing more detailed site selection guidelines for fixed cameras. As of early 2026, this project had not yet been undertaken.

For intersection sites, the current selection of camera sites is undertaken with the assistance of a formula developed by the Monash University Accident Research Centre (MUARC) in collaboration with Department of Justice and Community Safety (DJCS). The formula ranks intersection sites for camera placement based on a weighted average of medium and long-term crash history. A limitation of this approach is that intersection sites were not considered until a longer-term crash problem had arisen (Pearson, 2011). The Committee acknowledged this limitation and recommended developing a predictive model that incorporated factors such as traffic volumes, road geometry, and traffic manoeuvres to proactively treat high-risk intersections before crashes occur (Pearson, 2011).

The research being reported in this study is part of a Ph.D. program aiming to develop a comprehensive process for fixed traffic camera site selection that considers the full range of crash risk factors at an intersection to determine the

role played by non-compliance with speed limits and red lights. This study aimed to identify the differential impact of fixed digital speed and red light (FDSRL) cameras on crash outcomes related to site characteristics, traffic volumes and infringement rates to inform site selection optimisation.

Conference theme

This PhD provides a structured, evidence-based framework to support improved decision-making in automated enforcement deployment. The findings offer practical guidance for road safety agencies to enhance the strategic allocation of FDSRL cameras and maximise overall safety benefits. Accordingly, this study aligns closely with the ARSC2026 conference theme, which emphasises the application of scientific, evidence-based research to improve road safety and support the achievement of future road safety vision targets.

Method

The broader thesis comprises four key studies and a literature review chapter, which together contribute to the development of a theoretical framework for FDSRL camera site selection optimisation. This abstract focuses on Study 2 “Identification of data requirements to inform fixed speed camera site selection” and Study 3 “Establishment of the role of road design in FDSRL camera effectiveness”.

Study 2 identifies and defines the data requirements needed to build an evidence base that supports a proactive, systematic, and scientifically informed approach to FDSRL camera site selection in Victoria. A literature review and structured interviews with DJCS, Department of Transport and Planning (DTP) and the Road Safety Camera Commissioner were conducted to identify road, traffic, and enforcement variables associated with crash risk and camera effectiveness. Variables including traffic volume, number of lanes, intersection geometry, speed limit , infringement rates and crash history informed the development of a data framework used to support the data analysis undertaken in this research. The method adopted in this study was to match treatment sites to control intersections within the same postcode that also share similar road and traffic attributes. This approach strengthens the validity of comparisons and enhances the ability to isolate the effects of FDSRL cameras. All collected data were integrated into a GIS map, enabling the visualisation of FDSRL cameras, signalised intersections, and crash locations on a single map. This visualisation was essential for classifying sites into treatment and control groups, matching each treatment site with the most comparable control site, counting the before and after crashes at treatment and control sites, and initiating the analysis.

Study 3 outlines the study design and analytical approach used to evaluate FDSRL camera effectiveness in reducing crashes, identify the contextual factors influencing performance, and apply statistical techniques to achieve these objectives. A before- and-after quasi-experimental design was applied to selected camera sites using Poisson regression models to estimate crash reductions associated with FDSRLC installation and assess the differential effectiveness across site characteristics. It also presents and interprets the main findings from the analysis, providing insight into the conditions under which FDSRL cameras are most effective and informing the development of evidence-based deployment strategies.

Findings

The findings from Studies 2 and 3 highlight the substantial influence of intersection geometry, speed environment, number of lanes, and traffic volume on the effectiveness of FDSRL cameras along with crash statistics and infringement rates. Study 2 identified the key road and traffic attributes to be examined, based on evidence from the literature, as those most strongly associated with crash risk, including higher speeds, complex geometric design, wider roads, and a greater number of lanes. Study 3 then empirically tested the influence of these factors using a before and after quasi-experimental Poisson regression model, examining each attribute individually to ensure analytical clarity and control.

The analysis revealed that the safety benefits of FDSRL cameras are not uniform across all intersection characteristics. Clear patterns emerged showing that enforcement effectiveness is closely tied to the surrounding road and traffic environment. Specifically, intersections characterised by medium-to-high traffic volumes, narrower roadway widths, simpler intersection geometries, speed zones of 40, 60 or 80 km/h, and higher infringement rates demonstrated greater reductions in crash frequency associated with camera installation. For instance, FDSRL cameras deployment is most effective in 60 km/h zones, where crash risk decreased by approximately 20%, while analysis conducted by intersection geometry indicates that T-intersections exhibited the greatest reduction in relative risk, with a 43% decrease. Analysis by the number of traffic lanes in each direction shows that FDSRL cameras are most effective on roads with fewer lanes and sites with medium traffic volumes demonstrated the greatest improvement in safety outcomes, with a 23% reduction in crash risk. Analysis of relative risk by infringement rate category suggests the most substantial reduction in crash risk was observed at high-infringement sites with 28% crash reduction. These findings suggest that enforcement effectiveness is maximised when FDSRL cameras are deployed in environments with moderate exposure and manageable geometric complexity.

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Benefits to road safety

The road safety benefits of automated speed enforcement have been extensively studied. Generally, the aim of evaluating the efficacy of such technologies has been to assess road safety outcomes at an aggregate or program level. Evaluations have not focused on the differential effectiveness of cameras at different sites and the factors associated with these differences. Since previous research does not identify all the potential factors associated with optimal safety camera benefits, it is impossible to assess whether current automated enforcement systems are operating optimally. While best estimates of injury crash reductions attributable to fixed camera systems fall in the range of 20% to 25% at treated locations as evidenced in Thomas et al. (2008), it is possible that the measured effectiveness is constrained by site selection practice. Incorporating a more comprehensive range of factors than currently used, particularly relating to the road and road infrastructure has the potential to improve both the effectiveness of individual sites, as well as the effectiveness of fixed camera programs overall.

Implications for policy

Reflecting VAGO's conclusion that the guidelines for selecting fixed camera sites need to be more detailed, this research established the basis information to inform optimum site selection protocols, with a particular focus on the role that road infrastructure characteristics play in enforcement effectiveness. Outcomes from the study will inform the development of an optimization framework for the FDSRL cameras in Victoria.

Conclusions

This research demonstrates that FDSRL cameras are not necessarily most effective at intersections with the highest crash or speed profiles, but rather at those where the potential for crash reduction is greatest. This represents a conceptual shift from reactive, crash-history-based approaches to proactive, condition-based prioritisation.

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DRAFT

Driving safer behaviour: a smart School Zone Alert System

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Abstract
This study evaluated the NextGen School Zone Alert System (SZAS), an innovative safety intervention designed to address persistent driver non-compliance with 40 km/h limits in active school zones. Developed in response to ongoing speeding risks in high-pedestrian environments, the SZAS integrates radar-based speed detection, dynamic real-time messaging, and pedestrian monitoring to actively engage drivers and reinforce compliance at critical times. A 10-week controlled field trial was conducted at Wallsend South Public School in Newcastle, benchmarking system performance against the existing flashing light treatment. The system operated reliably under live traffic conditions and demonstrated measurable reductions in vehicle speeds, confirming its operational feasibility and capacity to influence driver behaviour. While approximately 42 per cent of drivers continued to exceed the posted limit, findings indicate that technology-enabled, real-time feedback can contribute to improved compliance beyond traditional signage alone. Importantly, the results highlight that sustainable behavioural change in school zones requires more than passive controls. The SZAS provides a scalable, data-driven platform capable of supporting targeted enforcement and education initiatives within a broader Safe System framework. Expanded multi-site trials across diverse, high-risk environments are recommended to quantify long-term behavioural impacts and guide evidence-based integration of advanced alert systems into school zone safety strategies.

Introduction
School zones represent a critical road safety priority in NSW, characterised by high pedestrian volumes – particularly children – during morning and afternoon peak periods. Although flashing school-zone signage has been implemented for more than 25 years, persistent challenges remain regarding driver compliance, ageing backend infrastructure, and reactive maintenance practices.

There are currently more than 6,800 school zone flashing light signs installed across NSW, with approximately 3,300 located in Greater Sydney and a further 3,500 distributed across the rest of NSW. These flashing lights support compliance with school zone speed limits across NSW by providing a visual cue prompting drivers to reduce speed upon entering designated school zones.

Excessive speed remains the leading contributor to death and injury on NSW roads. Annually, speeding is associated with approximately 42 per cent of road fatalities and 25 per cent of serious injuries, equating to nearly 128 deaths and 1,050 serious injuries each year (Transport for NSW, Centre for Road Safety). Higher speeds reduce available reaction time, increase stopping distances, intensify crash severity, and significantly elevate the likelihood of fatal or serious injury outcomes. Between January 2020 and December 2024, one fatal crash involving a school-aged pedestrian occurred within an active school zone, resulting in the death of a child in 2020. Over the same period, 84 school-aged pedestrians between 5 and 16 years were injured in active school zones (DART, TfNSW).

Objectives of the trial
There were four primary objectives of the trial:

1. To validate the effectiveness of next-generation SZAS technology in improving driver awareness, increasing compliance with the 40 km/h school zone speed limit, and delivering improved road safety outcomes
2. To provide an independent, evidence-based assessment to inform decision-making regarding refinement, expansion, and scaling of SZAS deployments across NSW school zones
3. To evaluate innovative system features, including pedestrian monitoring, radar-based vehicle detection, and two-line variable message sign (VMS) displays
4. To demonstrate the operational performance and reliability of the IoT-based Central Management System (CMS) in supporting real-time monitoring, remote operation, and predictive maintenance capabilities.

Conference theme
Evidence consistently demonstrates that speeding remains a persistent risk factor in active school zones, exposing children and other vulnerable road users to an elevated likelihood of serious injury or death. Existing control measures are not uniformly achieving sustained behavioural compliance, underscoring the imperative to translate empirical findings into targeted, system-level action. Further trials of innovative, interactive school zone alert systems will

generate robust operational data to inform iterative refinement, support scalable implementation, and strengthen collective accountability for protecting children within the road environment.

Achieving meaningful and lasting reductions in harm requires more than technological enhancement; it demands a coordinated shift in driver attitudes, social norms, and compliance behaviours. Through evidence-led system design, strategic stakeholder collaboration, targeted communication, and data-informed policy decisions, this initiative seeks to transform research insights into practical interventions. By integrating engineering innovation with education, enforcement, and community engagement, the program contributes to a proactive, future-focused approach to school zone safety aligned with broader road safety targets for 2030 and beyond.

Method

The trial employed a structured evaluation framework to assess the effectiveness of the SZAS. A before-and-after experimental design was implemented, comprising a control phase (Mode 0 – baseline operation) and four intervention phases (Modes 1 – 4) incorporating progressively enhanced system features (Table 1) (HiVis, 2025). This design enabled direct comparison of driver behaviour between under the existing flashing light system and the upgraded technology (Figure 1).

Table 1. Vehicle compliance with speed limits with each mode of operation within the school zone

Mode	Description
Mode 0 – Baseline (Current Operation)	Standard flashing lights only, replicating the existing NSW school-zone signage. Used as the control mode for comparison with enhanced features.
Mode 1 – Adaptive Flashing Lights (Overspeed Activation)	When a vehicle exceeded 40 km/h, all alert elements flashed at a faster rate until the vehicle slowed or passed the detection zone. Tests whether adaptive, speed-triggered alerts improve compliance.
Mode 2 – Baseline + Textbox	Standard flashing lights combined with a two-line VMS display, providing additional visual prompts reinforcing the 40 km/h limit.
Mode 3 – Adaptive Flashing Lights + Textbox	Overspeed-triggered fast flashing combined with VMS messages to deliver a multi-layered alert for non-compliant drivers.
Mode 4 – Pedestrian Crossing Message	VMS displayed “PEDESTRIANS CROSSING” alongside flashing lights when pedestrians were detected, reinforcing awareness at the crossing.

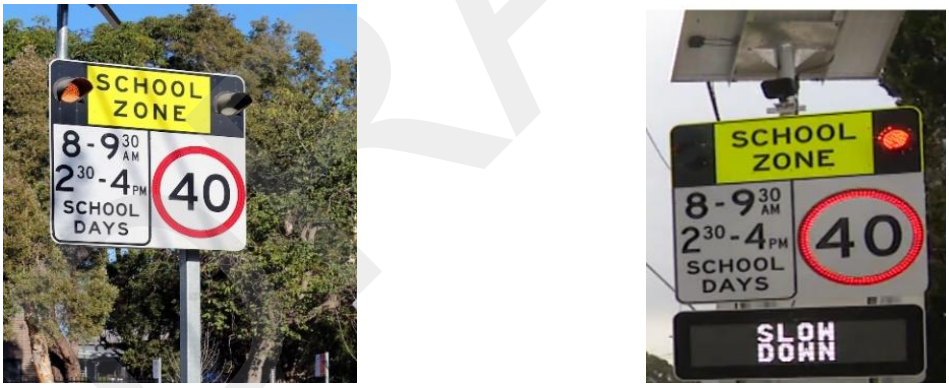

Figure 1. Standard school zone alert system compared to the NexGen school zone alert system

Data were collected from multiple sources, including radar-based speed logs, pedestrian monitoring cameras, system performance logs, and structured observational records.

The trial incorporated both quantitative and qualitative measures, including vehicle speed compliance rates, pedestrian detection accuracy, message update response times, and stakeholder feedback. These measures were designed to assess the technical performance, behavioural effects, safety outcomes, and operational reliability of the SZAS. Continuous system monitoring and incident recording were undertaken throughout the trial to verify technological performance. To ensure impartiality and analytical rigour, trial data were independently analysed by the University of Newcastle.

Results

The trial was conducted between July and September 2025, with each operational mode implemented for two-week intervals. Modest improvement in driver compliance was observed, with the highest compliance rate achieved under Mode 3 (Adaptive and Text Box) at 58.1 per cent, compared with 55.4 per cent in the baseline period. This represented a 2.7 per cent increase in compliance (Table 1) (HiVis, 2025). While overall compliance remained considerably below desired levels, these results indicate a small but measurable behavioural response to enhanced signage features.

Independent evaluation by the University of Newcastle reported similar modest reductions in vehicle speeds. Notably, the data demonstrated that signage alone is unlikely to reduce speeds below the mandated 40 km/h limit; the primary safety benefit is associated with reducing the proportion of vehicles exceeding the speed threshold rather than substantially lowering average speeds (Yang, 2025).

The highest-performing mode produced a 2.7 per cent improvement in speed compliance, contributing positively to school zone safety by reducing crash risk and severity. Despite this, approximately 42 per cent of drivers continued to exceed the 40km/h limit, indicating persistent non-compliance. The trial's primary benefit was the generation of robust evidence on the SZAS, enabling detailed analysis and informing subsequent refinement and deployment strategies.

Implications for policy and/or practice

Expanded trials and comprehensive data collection are required to evaluate behavioural change and confirm the effect of the SZAS on speed compliance. Consistent with findings that signage enhancements alone yield modest improvements, future deployments should prioritise high-risk school zones – particularly those with persistent speeding, high pedestrian volumes, multi-lane roads, or a history of crashes – where additional controls are likely to have the greatest impact on trauma reduction. Trial sites should encompass diverse geographies and road environments, including urban and regional settings, high-volume corridors, and varied road geometries. This approach will support a representative evaluation of the SZAS and facilitate evidence-based decisions regarding its integration within a broader Safe System strategy combining engineering, enforcement, and education to reduce road trauma.

Conclusions

The following recommendations identify the actions required to address observed gaps, strengthen the evidence base, and guide future decisions regarding the suitability of the SZAS for broader deployment, with the aim of improving road safety outcomes in school zones.

Expand Trials Across Multiple Sites and Timeframes

Extended trials should be conducted across a diverse range of environments. Multi-site, longer-duration trials will generate more robust and representative evidence of behavioural impact.

Evaluate Behavioural Strategies Beyond Signage

Future trials should investigate the effectiveness of the SZAS in conjunction with complementary behavioural interventions, such as targeted enforcement, school-community education or public awareness campaigns, and optimised, context-aware dynamic messaging.

Gather Broader Stakeholder Feedback

Structured qualitative input should be collected from schools, councils, crossing supervisors, parents, and road users. This feedback will support assessment of perceived vs measured safety impacts and guide user-centred refinements to the system and its implementation.

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Trends in road transport crash in New South Wales

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Abstract
Road transport deaths and serious injuries have risen sharply in recent years in New South Wales. Understanding which population and road user groups have the highest serious injury and death rates is crucial for road safety. Using linked police, health and mortality data from 2005-2024, we examined trends in serious injury and fatality rates per population and licence holders across age and road user groups. Rates of serious injury were up to eight times higher for motorcycle riders than drivers, with young riders showing the highest rates and steepest post-COVID increases, and older riders experiencing the largest relative growth over time. Our work provides important evidence to inform targeted interventions and highlights key areas for future research.

Background
Road transport deaths and injury have increased sharply in recent years in Australia and many other countries worldwide (A. A. A. Foundation for Traffic Safety, 2024; ITF, 2024). In New South Wales (NSW), 376 people died in a road transport crash in the last 12 months to March 2026 and 70 in 2026, a 18% and 40% increase compared with the previous 12 months and the same period in 2025, respectively (TfNSW, 2026). Young drivers and motorcycle riders are disproportionately affected (Australian Government, 2023; Mőller et al., 2021). Moreover, the number of older road user aged 65 and above seriously injured or killed in a crash increased in recent years. This is against a backdrop of an ageing population and increasing driver and rider licensing numbers, especially in the younger and older age groups and during the COVID-19 pandemic. Understanding which population and road user groups have the highest serious injury and death rates, how these have changed over time, and to what extend they are impacted by changes in population and driver licensing numbers is crucial for injury prevention measures. This analysis aims to explore trends of serious injury and road transport death to identify population groups with highest rates and highest increase over time.

Conference theme
This study fits within the overall conference theme "*From Evidence to Action: Shaping a Brighter Future*" by providing the evidence for targeted road safety measures and providing the foundation for more in depth future analysis.

Method
Setting: NSW is Australia's most populous state with an estimated 8 million residents (51% female) at the 2021 census (ABS, 2018). Of these 28% are aged 0-14years, 12% 15-24years, 52% 25-64 years and 18% 65 years or older. **Data sources:** We used the population-based NSW Centre for Road Safety (CRS) linked crash and health data resource. This includes police reported crash, health, mortality and compensation data collections from 2005-2024. Estimates of resident population were derived from the Australian Bureau of Statistics (ABS, 2025). Driver licensing data were obtained from Transport for NSW (2025). **Variables in the analysis and statistical analysis:** The main outcome measures were road transport injury resulting in hospital admission or death. These were identified from the diagnosis codes (ICD-10-AM S00-T98) and the external cause codes ICD10AM (V00-V89 and Y85) (IHACPA, 2019). A secondary outcome was injury severity measure was based on the International classification of disease injury severity score of the worst injury (Berecki-Gisolf et al., 2024). Exposures of interest were gender (male, female), age groups (16-24, 25-34, 35-54, 55-64, 65+) and road user groups. **Statistical analysis**: Number and rates of people seriously injured or killed in a road transport crash were calculated for calendar years 2005-2024. The analysis was stratified by road user groups, gender and age groups. Rates of serious injury or death by calendar year were calculated per population using ABS resident population projections and for drivers and motorcycle riders per licence holders.

Results
Between 2005 and 2024, the NSW population aged 16 and above increased by 30.5% to 6.9 million people, with a 67% increase in older age groups reflecting an ageing population. The number of driver and motorbike licences increased between 2005 (46%) and 2024 (66%). The largest relative increase occurred among older adults aged 65 and above, where driver licences increased 2.3-fold and motorbike licences increased nearly 5-fold. Licensing increased during the COVID-19 pandemic, particularly among young adults and older drivers (Figure 1). Over the 20-year period the number of adults seriously injured or killed in a crash increased, but population rates changed little. Reported numbers and rates were consistently higher for men compared to women. Men aged 16-24 had highest rates in comparison older women aged 65 and over had highest rates (Figure 2). Drivers accounted for the largest number of crashes resulting in serious injuries and deaths (Figure 3). The number of motorcyclists seriously injured or killed in a crash increased over

time. Older riders (aged 65 and over) had the highest relative increase of crashes in both serious injury (7-fold) and death (11-fold). Young riders (aged 16-24) had the highest rates of crashes resulting in serious injury and maximum severity injury and death and the steepest increase after easing of COVID-19 travel restrictions (Figure 4). Serious injury and death rates per licence holder were 8 times higher for motorcyclists than for drivers. Young motorcycle riders had the highest injury and death rates per licence holder, with up to 16 times higher rates compared to the oldest rider group. Among drivers, young and older licence holders had the highest serious injury rates.

Benefits to road safety

We identified age and road-user groups with highest serious injury and death rates and how these changed over time, especially after COVID-19 travel restrictions. We considered the impact of an ageing population and increase in licensing rates, this provides an evidence base to guide road safety initiatives and highlights areas for further research.

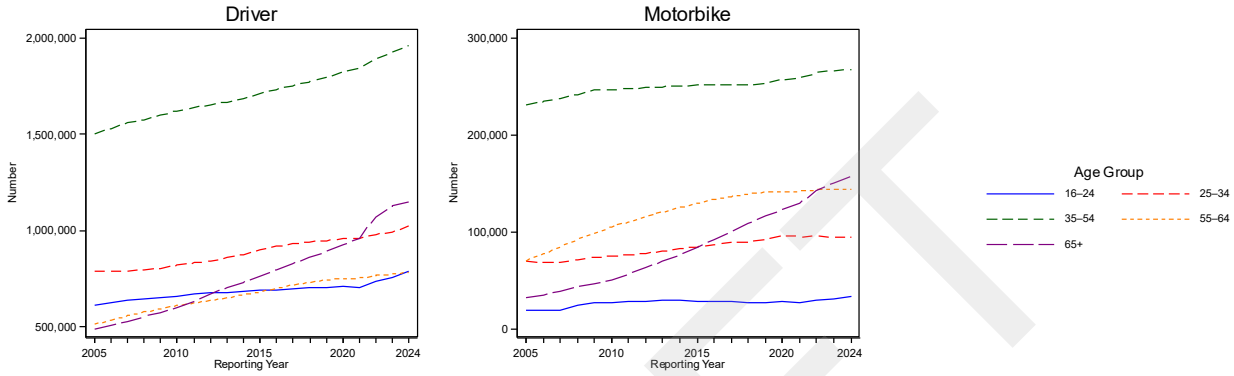

Figure 1. Number of car driver and motorcycle rider licences by age group, NSW 2005-2024

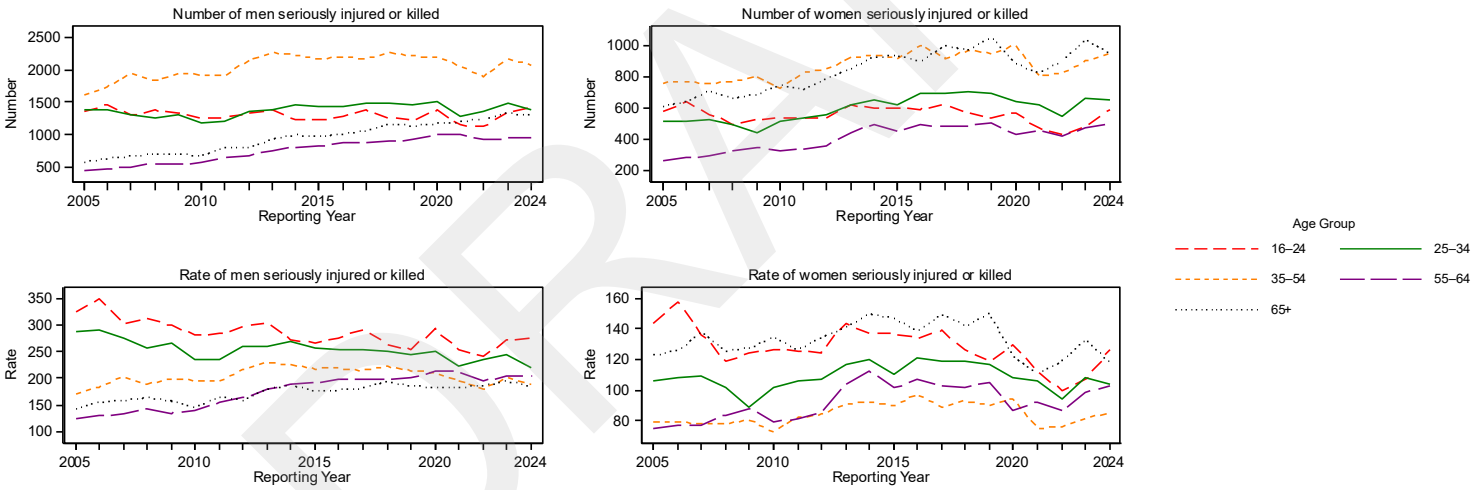

Figure 2. Number and rates per 100,000 population of men and women seriously injured or killed in a road transport crash (all road user groups) in NSW 2005-2024.

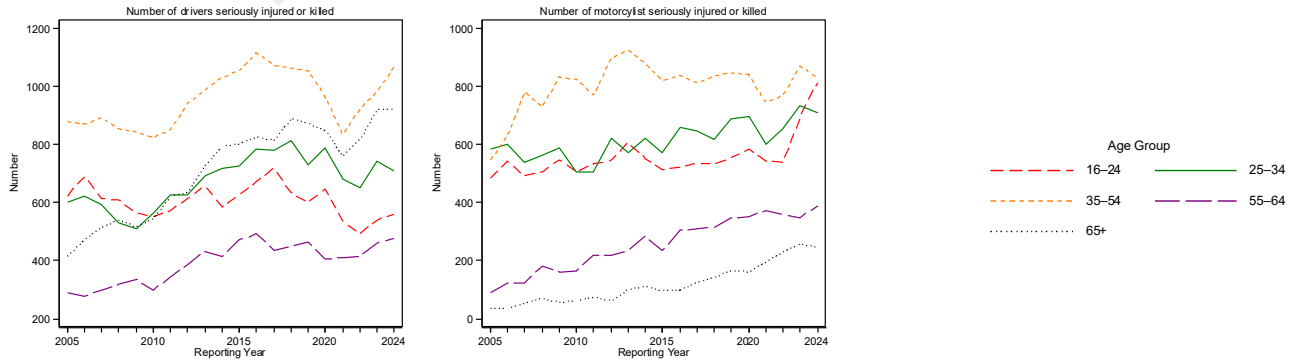

Figure 3. Number of drivers and motorcyclists seriously injured or killed in NSW 2005-2024

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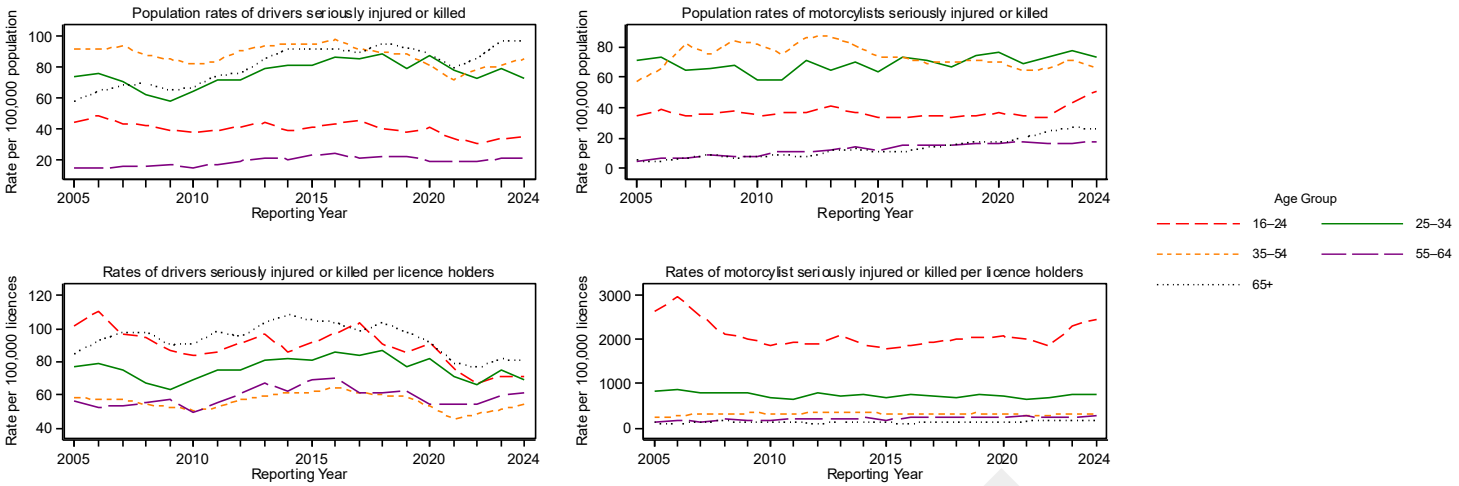

Figure 4. Rates of serious injury and death per population and licences for driver and motorcycle crashes, NSW 2005-2024

Implications for policy and/or practice

Targeted safety measures for young and older motorcycle riders are needed, given their disproportionately high and rising rates of serious injury and death. The post-COVID-19 increase in injuries for drivers and riders is of particular concern. Studies showed risky driving behaviours increased and compliance with safety measures decreased during and after lockdown periods contributing to increased crash rates (D'Elia et al., 2022: Tefft, 2024). This behavioural shift may reflect a broader societal change in risk perception and compliance after the COVID-19 pandemic with decreasing social cohesion (Melchinger et al., 2025; Scanlon Foundation Research, 2023) suggesting that road safety measures need to extend past education and infrastructure improvements considering the wider social determinants of health.

Conclusions

Our analysis highlights differences in serious injury and fatal crash rates among drivers and motorcyclists, with young and older riders and young drivers consistently over-represented. Rates of young motorcycle riders increased steeply in recent years after lifting of COVID-19 travel restrictions. Our work highlights areas for future including more in-depth analysis of recent increases in road transport injury and death and change in crash risk factors post covid using more sophisticated statistical analysis approaches.

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User perceptions of safety in multimodal street environments

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Abstract
Multimodal and shared streets aim to rebalance transport priorities and promote active and public transport, yet little evidence exists on pedestrians' perceived safety when interacting with other modes. Using an online survey of 1,676 respondents across New South Wales (Australia), this study models perceived pedestrian safety in interactions with cyclists, motorcyclists, cars, and heavy vehicles using Ordinal Logistic Regression (OLR). Results show that nearly 70% of respondents feel unsafe in at least one interaction, with pedestrians feeling safest around cars and least safe near heavy vehicles. Older and higher-income individuals report greater perceived safety, while women report significantly lower safety in heavy-vehicle interactions. Across the models, both medium- and high-income respondents generally report higher perceived safety than the low-income reference group, while midlife and older adults also report higher perceived safety than younger adults. Women report lower perceived safety when interacting with heavy vehicles.

Introduction
Car-oriented street design has historically prioritised motor vehicles, often creating environments that feel constrained or unsafe for pedestrians and cyclists However, cities are increasingly seeking to reduce car dependency and promote active travel to improve public health, environmental sustainability, and urban liveability (Batool et al., 2024). In Australia, only 34% of adults and 20% of children meet recommended physical activity guidelines, despite 86% of the population living in urban areas where active travel potential is substantial (Australian Bureau of Statistics, 2023). Street design strongly influences perceptions of safety in multimodal environments. Practice has shifted from strict separation of road users toward more context-sensitive shared spaces that balance movement and protection (Wijayaratna & da Rocha, 2025). While early shared space concepts emphasised full integration between users, raising safety concerns (Imrie, 2012), contemporary approaches rely on design cues, surface treatments and subtle separation to manage interactions. In Australia, shared zones formalise this approach through low-speed limits and pedestrian priority (Standards Australia, 2020). Safety of these environments have been mainly assessed through crash data, conflict analysis and speed measurements (Orsini, Batista, Friedrich, Gastaldi, & Rossi, 2023). However, perceived safety has received less attention, despite its influence on behavioural intentions such as willingness to walk, cycle, or allow children to travel independently (Wangzom, White, & Paay, 2023). This study addresses this gap by modelling pedestrians' perceived safety when interacting with cyclists, motorcyclists, cars, and heavy vehicles in shared and multimodal streets. Using 1,676 survey responses from New South Wales (Australia), four Ordinal Logistic Regression (OLR) models examine how socio-demographic characteristics, street-activity experiences, and infrastructure priorities influence safety perceptions across modal interactions.

Conference theme
This research supports the ARSC2026 theme "From Evidence to Action" by translating pedestrian safety perceptions into clear infrastructure priorities. While road safety policy often relies on crash statistics, nearly 70% of respondents report feeling unsafe in at least one modal interaction. The findings highlight the importance of pedestrian crossings, cycling infrastructure, public transport integration, signage, and street quality for improving safety perceptions.

Method
To examine how pedestrians perceive safety in shared and multimodal streets, an online survey was conducted across New South Wales (Australia). The data were analysed using Ordinal Logistic Regression (OLR) to identify how user characteristics, street-use experience, and infrastructure priorities influence perceived safety across different modal interactions.

Data Collection
The survey was administered in May 2025 and yielded 1,676 responses representative of the NSW population. Participants were presented with images of 12 case study locations selected across four street typologies (destination high streets, residential streets, connector streets, and shared intersections), reflecting low-speed, multimodal environments. The questionnaire consisted of four components: (i) socio-demographic characteristics (e.g., age, gender, income, employment), (ii) perceived ease of performing everyday street activities (e.g., walking, cycling, relaxing, children's play), (iii) prioritised street-design improvements (e.g., crossings, cycling facilities, signage, public transport,

street furniture), and (iv) perceived safety when interacting with cyclists, motorcyclists, cars, and heavy vehicles. Safety responses were recorded on an ordered Likert scale.

Modelling Approach: Ordinal Logistic Regression

Ordinal Logistic Regression (OLR), originally introduced by McCullagh (1980), is designed for outcomes that are ordered but not continuous. In this study, perceived safety is treated as an ordered response (from unsafe to very safe). The model assumes an underlying continuous latent variable representing an individual's true safety perception, which is segmented into ordered categories using estimated threshold parameters. Formally, the latent perception for individual i is expressed as:

$$Y_i^* = \beta X_i + \varepsilon_i \quad (1)$$

Where Y_i^* denotes the latent perceived safety for individual i; X_i is a vector of explanatory variables and β is a vector of estimated coefficients assumed constant across categories; and ε_i is a random error term following a standard logistic distribution. The observed ordinal outcome Y_i corresponds to intervals of Y_i^*, determined by threshold parameters δ_k:

$$Y_i = r_k \text{ if } \delta_{k-1} < Y_i^* \leq \delta_k, k = 1,2, \dots, K \quad (2)$$

The probability that an observation belongs to category r_k can then be expressed as the difference between cumulative probabilities:

$$P(Y_i = r_k) = P(Y_i^* > \delta_{k-1}) - P(Y_i^* > \delta_k) = \frac{1}{1 + e^{-(\beta X_i - \delta_k)}} - \frac{1}{1 + e^{-(\beta X_i - \delta_{k-1})}} \quad (3)$$

In this formulation, the coefficients β describe the direction and magnitude of each explanatory variable's influence on perceived safety. A positive coefficient increases the likelihood of reporting a higher safety level, while a negative coefficient indicates the opposite.

Results

Perceived Safety Across Modal Interactions

Table 1 summarises pedestrians perceived safety when interacting with different transport modes. Interactions with cars were perceived as the safest, with 59% of respondents reporting safe or very safe experiences and 20% reporting unsafe interactions. Safety perceptions decline for cyclists and motorcyclists, where about half of respondents feel safe, and are lowest for heavy vehicles, with only 44% reporting safe and 33% unsafe experiences. Overall, only 27% feel safe across all interactions, while around 70% feel unsafe in at least one, indicating widespread perceived vulnerability in multimodal streets.

Table 1. Distribution of perceived pedestrian safety across interaction types

Interaction with	Safe/Very safe	Neutral	Unsafe/Very unsafe
Cyclist	49%	20%	32%
Motorcyclists	52%	21%	27%
Cars	59%	21%	20%
Heavy Vehicles	44%	23%	33%
Any Interaction	27%	3%	70%

Determinants of Perceived Safety

Table 2 summarises the key determinants of perceived safety across the four Ordinal Logistic Regression models that were developed. Model accuracy ranges between 0.51 and 0.59, consistent with perception-based ordinal models. Across the models, older and higher-income respondents report higher perceived safety, while women report lower safety when interacting with heavy vehicles. Streets perceived as supportive of everyday activities across all users, particularly "Children playing" and "Accommodating all ages" variables, are associated with higher perceived safety. Infrastructure conditions consistently influence perceptions. Lower ratings for "Areas for pedestrians", "Designated pedestrian crossings", and "Signage" significantly reduce perceived safety, while the increased presence of and speed of motor vehicles reduces safety across all interaction types.

Benefits to road safety and policy implications

The modelling results highlight several priorities for improving safety in multimodal streets. Increasing perceived deficiencies raises the probability of respondents reporting unsafe conditions and reduces the likelihood of safe perceptions. Public transport integration exerts the strongest influence across models, suggesting that coherent multimodal environments play a central role in shaping pedestrian comfort. Deficiencies in cycling infrastructure, along with lower ratings for pedestrian space and designated crossings, consistently increase unsafe perceptions. Overall, improvements to pedestrian space, crossings, cycling facilities and multimodal transport integration are likely to produce the greatest gains in perceived pedestrian safety. The findings suggest several priorities for practice. High-quality pedestrian infrastructure, including continuous pedestrian space and clearly defined crossings, are essential.

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Traffic management measures addressing the number and speed of motor vehicles, such as lower speed environments and traffic calming treatments, can reduce both perceived and actual conflict risk. Effective signage and traffic controls can improve the predictability of interactions between modes, while stronger public transport and cycling integration can better organise street space and reduce conflict between users.

Table 2. Summary of key determinants of perceived pedestrian safety across interaction models

Determinant	Cyclist Interaction	Motorcyclist Interaction	Car Interaction	Heavy-Vehicle Interaction
Midlife adults (35-54)	0.88^{***}	0.91^{***}	0.86^{***}	0.63^{***}
Older adults (55-74)	0.81^{***}	1.05^{***}	0.95^{***}	0.72^{***}
Women	ns	ns	ns	-0.41^{*}
Medium income ($ 45,000-135,000)	1.18^{***}	1.47^{***}	1.17^{***}	1.40^{***}
High income ($ 135,000 or more)	1.20^{***}	0.95^{***}	0.96^{***}	1.22^{***}
Children playing	0.21^{***}	0.24^{***}	0.14^{***}	0.31^{***}
Accommodating all ages	0.38^{***}	ns	0.17^{*}	0.155^{*}
Drive car	0.28^{**}	0.48^{***}	0.62^{***}	0.26^{***}
Need for improved pedestrian areas	-0.49^{***}	-0.43^{***}	-0.47^{***}	-0.46^{***}
Need for improved pedestrian crossings	-0.59^{***}	-0.43^{***}	-0.47^{***}	-0.42^{***}
Need for improved signage	-0.55^{***}	-0.43^{***}	-0.47^{***}	-0.33^{***}
High number/speed of motorised vehicles	-0.59^{***}	-0.46^{***}	-0.43^{***}	-0.48^{***}
Need for improved public transport	-0.53^{***}	-0.44^{***}	-0.47^{***}	-0.42^{***}
Need for improved cycling infrastructure	-0.45^{***}	-0.43^{***}	-0.41^{***}	-0.34^{***}

Note: ns: non-significant, *: P < 0.05, **: P < 0.01, ***: P < 0.001

Conclusions

This study analysed pedestrians' perceived safety in interactions with cyclists, motorcyclists, cars, and heavy vehicles using 1,676 survey responses from New South Wales and Ordinal Logistic Regression models. Safety perceptions varied across modes, with heavy vehicles associated with the lowest perceived safety. Pedestrian safety perceptions were strongly influenced by street design quality, particularly pedestrian space, crossings, signage, and traffic conditions. Future research should combine perception surveys with objective street and behavioural measures to provide a more comprehensive understanding of pedestrian safety in multimodal environments.

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Designing a data linkage approach for Commercial Passenger Vehicle fatigue-risk

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Abstract
Due to the multi-factorial nature of fatigue, challenges with measurement, and inconsistent recording in crash reporting, fatigue involvement in crashes is difficult to quantify. This study developed a data linkage approach to enable measurement of fatigue-relevant crash risk in Victoria's commercial passenger vehicle (CPV) sector. A data conceptual framework was developed through a scoping review and consultations with government, regulatory, and industry stakeholders to identify risk factors and measurable proxies for fatigue-relevant outcomes and exposures. Deterministic linkage (using de-identified person and vehicle identifiers) combined: (1) police-reported crash data (RCIS data for 2014–2024), (2) CPV licensing and infringement records (DLS data at August 2025), and (3) CPV trip data (2019–2024). The linked dataset comprises 247,461,023 trips from 103,766 drivers (80.3% rideshare), including 8,414 CPV driver-involved crashes (8,076 accredited CPV drivers). This linkage approach provides a novel method for examining fatigue-related risk patterns and modifiable system-level contributors in CPV operations.

Introduction
Fatigue is a persistent contributor to road trauma internationally, but it remains challenging to quantify through existing data sources. Unlike alcohol and drug impairment, fatigue is rarely measured directly in operational settings and is not consistently recorded as a causal factor in crash databases (Dawson et al., 2018; Dobbie, 2002; Filtness et al., 2017). In practice, fatigue-related crash involvement is often inferred using proxy indicators (e.g., crash configuration, time-of-day, single-vehicle departures, absence of evasive manoeuvres), each with limitations in sensitivity and specificity (Filtness et al., 2017; Palamara, 2016). This creates a methodological challenge as it is difficult to measure the contribution of fatigue impairment to a crash event reliably within any single dataset.

In the commercial passenger vehicle (CPV) sector, fatigue risk is likely elevated due to interacting determinants across multiple system levels (Gander et al., 2011; Miller et al., 2020). These include driver-level factors (sleep opportunity, circadian timing, health), operational exposure and workload (work hours, task demands, time-on-road), organisational and economic context (scheduling practices, incentives, safety culture), the vehicle and technology factors, and the external operating environment (road type, traffic, weather, monotony). As these determinants are distributed across a range of administrative and operational systems, single-source data are typically insufficient to characterise exposure-outcome relationships or identify actionable high-risk operating contexts. A linked administrative data study offers a pathway to quantify fatigue-related crash-risk at scale, but only if the study is underpinned by: (i) a defensible conceptualisation of fatigue-related crash risk, (ii) transparent operational definitions for outcomes and exposures, and (iii) a clear set of variables aligned to what can be measured reliably across the systems being linked. Without this foundation, linked-data studies run the risk of misclassifying outcomes, or omitting system-level determinants that are important for prevention.

This project was commissioned by Safe Transport Victoria to strengthen evidence-informed approaches to fatigue risk management in Victoria's CPV sector, by establishing a sector-relevant measurement approach and applying it within a linked-data design to support targeted regulatory and industry action.

Study Aim and Rationale
The aim of this study was to develop a linked dataset that enables measurement of fatigue-relevant crash risk and contributing factors in Victoria's CPV sector. Data linkage facilitates the integration of multiple data sources to enable system-level assessment of risk, and to identify relevant conditions and operational contexts which are most associated with fatigue-relevant crash risk.

Conference theme
This study aligns with *From Evidence to Action: Shaping a Brighter Future* by translating evidence and sector expertise into regulatory-ready outputs with a clear pathway to implementation. The work has been commissioned by the Victorian regulator, and will be used to inform the development of internal dashboards to monitor fatigue risk over time and inform fatigue risk management. All elements of this project have been conducted in consultation with government and industry to ensure operational relevance.

Method
This study used a mixed-methods approach. The first stage was development of a data conceptual framework to guide data linkage and subsequent analyses. Key fatigue-related factors relevant to fatigue-related crash risk in the CPV sector were identified through a rapid evidence review and the screening of available administrative datasets to assess measurability and to define fatigue-relevant outcomes and exposures. These candidate factors were then refined through consultations with key government, regulatory and industry stakeholders to ensure the framework reflected operational realities, and clarified feasible indicators and proxies in administrative systems. The final framework specified the domains, candidate measures and operational definitions used to plan linkage requirements and analytic variables.

Data sources and linkage process
Victoria Police-reported fatal and injury crashes were extracted from the Road Crash Information System (RCIS), maintained by the Department of Transport and Planning (DTP). RCIS captures information on vehicles and persons involved, crash location and time, roadway and environmental characteristics, and crash outcomes (with injury outcomes supplemented by Transport Accident Commission data). For CPV linkage, RCIS crashes involving CPV drivers registered in Victoria were deterministically linked to DTP licensing and infringement data for persons holding CPV Driver Accreditation and registered with Safe Transport Victoria, and to CPV trip data provided to Safe Transport Victoria by registered taxi and rideshare service providers. The linkage was undertaken in SPSS, using accredited CPV licensing data as the parent dataset. Person and vehicle numbers were created specifically for this study and were used as linkage keys across datasets. As these numbers did not reflect actual values in the source data, they prevent linkage of the study data with any other external datasets and removed the ability to re-identify specific persons or vehicles.

Prior to linkage, datasets were assessed for missingness. Missingness was uncommon and mainly related to date-time, or spatial variables (e.g., trip start/end co-ordinates). Given the nature of these fields, missing values were not imputed. Numeric and date-time values were converted from text strings, and inconsistent free-text values (common in service-provider submissions) were recoded where logical (e.g., standardising Boolean entries), with values which were incompatible with a specific variable's data type set to 'unknown'. Where rideshare, taxi and Multi-Purpose Taxi Program (MPTP) trip datasets used different variable names for conceptually equivalent fields, harmonised variables were created to preserve the integrity of original data while enabling combined analyses.

Data analysis used a 1:1 matched case–control design (without replacement) to estimate associations between fatigue-relevant exposure proxies and crash involvement among CPV drivers. Cases were defined at first crash during July 2021–June 2024 and matched on sex, birth month/year and year of first CPV trip; controls were drivers without a crash in the same period (n=6,182; 3,091 pairs). Conditional logistic regression estimated odds ratios (95% CI) for each exposure measure, with correlations examined to assess relationships among measures. Fatigue-relevant exposures were operationalised from linked trip data (e.g., night/early-morning activity, extended work windows, cumulative trip duration/distance) and licensing/infringement history, with RCIS crash circumstances (e.g., time-of-day, crash configuration) used for fatigue-relevant classification and sensitivity analyses.

Results
Framework output
The scoping review and stakeholder consultations produced an evidence-based data conceptual framework describing fatigue-related crash risk in the CPV sector, encompassing driver, work/operational exposure, organisational/regulatory context, vehicle/technology and environmental/road context domains. The framework mapped each domain to measurable administrative indicators and feasible proxies (e.g., licensing and infringement history; crash circumstances; trip-derived exposure measures; compliance-related markers; and road/temporal context variables). Stakeholder input refined proxy definitions confirmed operational relevance and prioritised modifiable determinants with prevention leverage, thereby defining the linkage variable set and informing operational definitions for fatigue-relevant outcomes and exposures. The framework outputs were used to specify the linkage variable set and to operationalise fatigue-relevant crash classification using transparent proxy rules, ensuring the linked dataset is fit-for-purpose for fatigue-risk measurement.

Linked data characteristics
Preliminary analysis identified that over the study period, there were 8,414 CPV driver-involved crashes involving 24,198 persons; 33.4% of persons were accredited CPV drivers (n=8,076). The CPV driver may have been involved as the driver of a CPV, the driver of some other vehicle, or as a passenger, pedestrian or some other road user type (e.g.,

motorcyclist). Most crashes involved collision with another vehicle (approx. 84%), including 5,460 two-vehicle collisions; a further 1,154 were single-vehicle incidents. Most crashes resulted in minor injury (67.5%), with 31.6% classified as serious injury crashes; 73 crashes resulted in a fatality (0.9%). CPV drivers in crash records were predominantly male (95.6%) with a mean age of 37.2 years (SD=11.8). Crash circumstances indicated that 59.2% occurred in daylight, 8.9% at dawn/dusk and 28.4% in dark conditions. Crashes were commonly recorded at cross intersections (27.9%) and T-intersections (22.3%). Speed environments were concentrated in 60 km/h zones (36.8%), followed by 80 km/h (16.5%), 50 km/h (12.9%) and 40 km/h (11.1%) zones. Trip data were available for July 2019 to June 2024 and comprised 247,461,023 trips completed by 103,766 drivers. Driver demographics in trip data were similar to crash data: 95.3% were male, with a mean age of 41.5 years (SD=12.1). Rideshare accounted for 80.3% of booked trips; the remainder were pre-booked taxi trips, of which 45.8% were booked under the MPTP. Trip and licensing data supported derivation of exposure indicators relevant to crash risk (e.g., distance and duration per driver per trip) and offence history, with speeding comprising 70.9% of recorded road safety-related offences (48.7%: 1–9 km/h over; 20.0%: 10–24 km/h over).

Benefits to road safety

The principal road safety benefit of this project is the development of a linked CPV dataset that includes work patterns, crashes, and licensing history over time. This dataset can be used to help quantify fatigue-related crash risk in the CPV sector using routinely collected administrative data. By integrating exposure indicators and crash outcomes across systems, the linkage supports identification of risk at a system level, and identifies the conditions and operational contexts most strongly associated with fatigue-related crashes. These insights are intended to support the development of targeted strategies, and to prioritise interventions with the greatest prevention leverage.

Implications for policy and/or practice

The linked-data outputs provide a basis for risk-based analysis of fatigue-related crashes in the CPV sector. This can inform prioritisation of education, compliance and auditing activity and refine education and engagement strategies to align with observed risk patterns. For CPV duty holders, results can highlight modifiable system-level contributors, such as operational exposure patterns and organisational practices that offer prevention leverage.

Conclusions

This study developed and applied an evidence and stakeholder-refined data conceptual framework to guide linked administrative data analyses of fatigue-related crash risk in Victoria's CPV sector. The framework mapped key determinants to feasible indicators and informed linkage specifications and operational definitions for fatigue-relevant outcomes and exposures. The linked dataset integrates CPV crash involvement and circumstances with operational trip exposure and licensing/infringement histories, enabling system-level identification of where risk concentrates and supporting targeted prevention strategies. For CPV linkage, the dataset includes 8,414 CPV driver-involved crashes (2014–2024) and 247 million trips (2019–2024). These outputs will support targeted education strategies and inform priorities for fatigue risk management and monitoring.

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DRAFT

Enhancing cyclist and pedestrian safety in Torquay, Australia

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Abstract
Traditional roundabout designs often lack safe crossing infrastructure for vulnerable road users and may discourage less confident individuals from cycling or walking. This case study outlines a rigorous process within a Safe System approach for identifying, designing and selecting road upgrades to improve cyclists and pedestrian safety while encouraging active transport. A vulnerable road user access study including Road Safety Audit (RSA) of Fischer Street, Torquay, found multiple cyclist and pedestrian safety problems at existing roundabouts and mid-block locations. Three potential options were identified and scored using SSA and MCA methods, from which Option 1 was selected as the best balance of safety objectives with amenity and feasibility factors. The installed treatments included raised platform crossings which enhance vulnerable road users (VRU) visibility and reduce vehicle speeds, separated paths to reduce VRU exposure, and improved delineation and markings to enhance guidance at conflict points.

Introduction
Traditional roundabout designs often lack safe crossing infrastructure for vulnerable road users, particularly cyclists and pedestrians. Cycling facilities at roundabouts are usually limited to on-road bicycle lanes alongside traffic lanes or to sharrow markings, requiring cyclists to share the traffic lane with other vehicles. Pedestrian facilities at roundabouts are variable, and footpaths typically provide separation from traffic on approaches, but there is often limited guidance, positive protection or other safety enhancements at crossing points. These facilities pose serious safety risks and may discourage less confident individuals from cycling or walking, as they may see these intersections as barriers.
As vulnerable road users (VRU), cyclists and pedestrians face some common key risks. These include a smaller profile making them less visible to motorists and increasing the risk of being overlooked or not given way; greater risk of severe injury due to lack of protection and interactions with large, heavy vehicles; frequent presence in motorists' blind spots increasing the likelihood of accidents; and conflicts due to opposing movements of other road users. The relationship between impact speed and fatal pedestrian injury risk is well documented and informs Safe System assessment of road network risk factors: conservatively, impact with a car travelling at 30km/h is estimated to be survivable in 90% or more of cases, with the risk of fatality increasing on average by 11% for every 1km/h increase in impact speed according to Hussain et al. (2019). While bicycle crashes can be said to be more variable in terms of crash configuration and therefore outcomes, these estimates may be considered similar for cyclists in some crash scenarios. These circumstances demand low speeds and other protections where vulnerable road users frequently mix with motorised vehicle traffic, especially at conflict points such as intersections.

The Dutch Safe System approach to street design and cyclist mobility has been adopted in full or modified form in other jurisdictions and follows core principles that a cycling route or network should be cohesive, direct, safe, comfortable, and attractive for cyclists (Wegman & Schepers, 2024; van Ommeren et al., 2017; Fonseca et al., 2023). This approach informed the development of an 'infrastructure first' upgrade solution for an urban collector road with medium-high pedestrian and cyclist activity in the coastal town of Torquay, Victoria.

Conference theme
This research directly supports the conference theme by presenting a practical case study example of an important infrastructure upgrade that is directly informed by evidence to improve cyclist and pedestrian safety.

Project description
Road Solutions conducted a vulnerable road user access study including Road Safety Audit (RSA) of Fischer Street in Torquay, finding multiple cyclist and pedestrian safety problems at existing roundabouts and mid-block locations. As a key cycling route between Torquay and Torquay North, Fischer Street sees high and growing levels of pedestrian and cyclist activity, including many schoolchildren who commute daily. Cyclists often encounter moderate traffic volumes at intersections, especially at roundabouts, since the street also serves a collector function and intersects roads linking Surf Coast Highway and the beachfront. While heavy vehicle volumes are low, buses and some heavy vehicles remain. Fisher Street has a history of intersection, rear end and run off road type crashes. The Surf Coast Shire Council determined that there was a need for safety upgrades and/or alternative options for cyclists and pedestrians using Fischer Street.

Process and actions
Safe System Assessment (SSA) and Multi-Criteria Analysis (MCA) identified and ranked three potential options to

improve VRU safety on and around Fischer Street (Figure 1). Options analysis considered the main themes of a shared user path, including Strategic Cycling Corridor (SCC) principles, comfort & attractiveness, social aspects, environment, and ease of implementation. Next, in each theme, the criteria and performance indicators for each criterion were defined. Each alignment option was then scored from -3 (major negative impact) to 3 (major positive impact) based on the criteria and performance indicators. Option 3 was the least safe and least desirable option with an MCA score of 1.96. On safety criteria alone, Option 2 appeared best but only marginally safer than Option 1. When all criteria were considered in MCA, including directness, attractiveness and ease of implementation, Option 1 emerged as most preferred with an MCA score of 2.13 compared with 2.04 for Option 2.

Figure 1. Options derived from Safe System Assessment and Multi-Criteria Analysis (Google Maps)

Having selected Option 1, Road Solutions and Surf Coast Shire Council developed and designed several protected roundabouts to improve pedestrian and cyclist safety along Fischer Street. Pre- and post-intervention images are shown in Figures 2 and 3, respectively.

Figure 2. Pre-intervention Fischer St intersections, Inshore Dr (L) and Darian Rd (R) (Google Maps)

The roundabouts installed have raised safety platforms with priority crossings on all intersection legs and separated off-road bicycle paths and footpaths. Protected roundabouts separate cyclists from traffic by transitioning them off-road at the intersection, reducing cyclist exposure and crash risk. The raised platforms also provide Safe System-aligned crossings by reducing vehicle speeds approaching the crossings.

Figure 3. Post-intervention Fischer St intersections, Inshore Dr (L) and Darian Rd (R) (Road Solutions)

Benefits to road safety

The key benefits of the protected roundabout include:

- Improved cyclist safety by eliminating exposure to vehicular traffic within the roundabout.
- Facilitated safe crossing of both cyclists and pedestrians around the roundabout.
- Reduced level of traffic stress for cyclists travelling through the intersection.
- Improved attractiveness and directness of the cycling route, especially for less confident individuals.
- Encouraged active transport by removing barriers within the route.
- Provided separation between pedestrians and cyclists to improve pedestrian safety.
- Improved sightlines between motorists and cyclists at conflict points.

The implementation of protected roundabout cycling facilities along Fischer Street is a significant step forward in improving safety and accessibility for cyclists and pedestrians. By addressing long-standing risks and barriers, these measures reduce crash risks and traffic stress and encourage greater uptake of active transport. As Fischer Street continues to grow as a key cycling route, further improvements will be implemented, particularly to mid-block cycling facilities to help create a safer, more inclusive, and sustainable environment for all users.

Implications for policy and practice

This case study demonstrates a rigorous evidence-based planning process for the development and implementation of cyclist and pedestrian safety improvements. Leaning heavily on the Dutch Safe System approach to street design, SSA and MCA allow safety to be prioritised while also considering other crucial factors such as feasibility, directness, attractiveness, comfort and cohesion. Consideration of all these factors is likely to encourage active transport while also improving safety. Future evaluation of the Fischer Street upgrades using appropriate datasets is warranted to objectively determine the safety and mobility outcomes.

Conclusions

This project summary outlined a rigorous process within a Safe System approach for identifying, designing and selecting road upgrades to improve cyclists and pedestrian safety while encouraging active transport. Three potential options were identified and scored using SSA and MCA methods. The installed treatments included raised platform crossings which enhance VRU visibility and reduce vehicle speeds, separated paths to reduce VRU exposure, and improved delineation and markings to enhance guidance at conflict points.

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DRAFT

Rising motorcycle crash burden in Zambia: eight-year policy evidence

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Abstract
Motorcycles are among the fastest-growing road user groups in sub-Saharan Africa, yet their crash burden remains poorly characterised in most low- and middle-income countries (LMICs). This study analyses eight years (2017–2024) of national police crash data from Zambia's Road Transport and Safety Agency to quantify trends in motorcycle involvement, injury severity, provincial distribution, and behavioural risk factors. Motorcycle involvement in reported crashes more than doubled, from 2.6% in 2017 to 6.6% in 2024, with a statistically significant annual odds-ratio of 1.18. Motorcyclists' share of road fatalities rose from 6% to 15% over the same period; by 2024, motorcyclists accounted for nearly one-quarter of all seriously injured road users. Eastern and Muchinga provinces consistently recorded the highest crash concentrations. Excessive speed and failure to keep to the near side were the dominant behavioural causes. These findings provide an evidence base for targeted, motorcycle-specific road safety interventions in Zambia and comparable LMIC contexts.

Introduction
The United Nations Decade of Action for Road Safety 2021–2030 targets a 50% reduction in road traffic deaths and serious injuries by 2030 (WHO, 2021). Sub-Saharan Africa carries a disproportionate share of global road trauma: the region accounts for roughly 19% of global road deaths despite owning less than 3% of the world's vehicles (WHO, 2023). Within this context, powered two-wheelers — motorcycles, mopeds, and motorised three-wheelers — have proliferated rapidly as affordable transport, yet they are among the most crash-vulnerable road user types (Bachani et al., 2017).

Zambia provides an instructive case study. Rapid urbanisation, expanding informal motorcycle-taxi operations, and limited enforcement capacity have created conditions for a growing motorcycle crash epidemic (RTSA, 2024). Despite routine crash recording by the Zambia Police, no peer-reviewed longitudinal analysis of motorcycle-specific trends has been published. This evidence gap limits the design of targeted interventions and makes it difficult to mobilise political will or allocate resources.

This study fills that gap by providing the first eight-year quantitative analysis of motorcycle crash burden across Zambia at both national and provincial levels, covering the period 2017–2024.

Conference Theme
This submission directly addresses the 2026 ARSC theme From Evidence to Action: Shaping a Brighter Future. Zambia risks missing the 2030 SDG road safety targets unless motorcycle-specific action is taken. By translating eight years of police crash data into actionable findings on trend trajectories, provincial hotspots, and behavioural causes, this work demonstrates the kind of evidence-to-action pipeline the conference seeks to promote. The study also speaks to LMIC collaboration and knowledge transfer: the analytical framework developed here is replicable across the broader Australasian-African road safety research community.

Methods
Data were obtained from police annual crash statistics databases covering 2017–2024 (eight consecutive years). Motorcyclist casualties were defined as Motor Cycle Drivers and Motor Cycle Passengers. Annual counts and proportional shares were computed for each severity level. Trend significance was assessed using binomial logistic regression within the Generalised Linear Modelling (GLM) framework using a logit link function, with year as a continuous predictor and motorcycle involvement/share as the binary or proportion outcome. All analyses were conducted in R version 4.4.1 (R Core Team, 2024). Provincial hotspot analysis ranked provinces by annual motorcycle crash share. Behavioural risk factors were identified from cause-of-accident codes.

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Results

Rapid growth in motorcycle crash involvement

Motorcycle involvement in reported road crashes increased from 2.6% of all vehicle mentions in 2017 to 6.6% in 2024, a 154% relative increase. The trend was highly statistically significant (OR = 1.18 per year, 95% CI: 1.17–1.19, $p < 0.001$), indicating an 18% increase in the odds of a crash involving a motorcycle for each additional calendar year.

Table 1. Motorcycle crash burden in Zambia, selected years 2017–2024

Year	Moto share of crashes	Fatal (motorcyclists)	Fatal share (%)	Serious share (%)
2017	2.6%	120	6.0%	6.6%
2019	3.0%	112	6.4%	9.6%
2021	3.3%	112	5.2%	7.6%
2022	4.2%	217	9.7%	15.0%
2023	6.1%	262	13.0%	15.8%
2024	6.6%	331	15.1%	22.9%

Source: Zambia Road Transport and Safety Agency crash statistics databases, 2017–2024.

Accelerating injury severity burden

Across all three severity levels, motorcyclists' share rose steeply from 2022 onwards. The fatal share trend was significant (OR = 1.21/year, 95% CI: 1.18–1.24, $p < 0.001$). In 2024, motorcyclists accounted for 15.1% of all road deaths (n = 331), 22.9% of serious injuries (n = 1,329), and 21.1% of slight injuries (n = 2,131) — despite representing only ~6.6% of crash-involved vehicles.

Provincial hotspots: rural and peri-urban concentration

Eastern Province recorded the highest motorcycle crash share consistently across all eight years (8.4% in 2017, rising to >15% in 2020–2024). Muchinga and Luapula provinces also featured persistently among the top three hotspots. These provinces are characterised by high reliance on motorcycle taxis, limited enforcement presence, and predominantly rural/unpaved road conditions, factors associated with heightened crash risk in comparable LMIC settings.

Behavioural and temporal risk factors

Excessive speed (cause code A4) and failure to keep to the near side (A5) consistently ranked as the top two crash causes throughout the study period, collectively accounting for more than 50% of total recorded crash causes each year. Saturday and Friday had the highest crash frequency (approximately 16–17% of weekly crashes each), and the 18:00–20:00 hour was the peak crash time band across all years, followed closely by 20:00–23:59.

Benefits to Road Safety

This study provides the first systematic, longitudinal evidence of Zambia's motorcycle crash epidemic, establishing a rigorous baseline for monitoring and intervention. The provincial hotspot analysis enables geographically targeted resource allocation. Identification of speed and lane-positioning as dominant causes provides a direct evidence base for enforcement priorities. More broadly, the analytical methodology is transferable to any LMIC with police crash reporting systems, supporting capacity-building across the region.

Implications for Policy and/or Practice

The findings carry direct policy implications at national and provincial levels:

- Motorcycle-specific road safety strategy: Zambia lacks a dedicated powered two-wheeler safety plan. The scale and trajectory of findings justify urgent development of one, with enforceable helmet standards, operator registration, and minimum roadworthiness requirements.
- Targeted provincial enforcement: Graduated enforcement campaigns in Eastern, Muchinga, and Luapula provinces, prioritising speed and lane discipline, would address the highest-burden locations identified here.
- Evening and weekend intervention: Crash peaks on Friday–Saturday evenings suggest value in time-targeted enforcement operations and public communication campaigns timed to those windows.
- LMIC knowledge transfer: The analysis framework and findings can support neighbouring countries, and ARSC delegates working in Low and Middle Income Country contexts, in making the case for motorcycle safety investment with their own data.

Conclusions

Motorcycle crash burden in Zambia has more than doubled in eight years and is accelerating. Motorcyclists now account for 15% of road fatalities and nearly 23% of serious injuries, a wholly disproportionate share relative to their presence in traffic. The concentration in rural provinces, the dominance of speed-related causes, and the evening–weekend temporal peak all point to a tractable set of interventions: targeted enforcement, a dedicated national motorcycle safety strategy, and regulatory frameworks for the motorcycle-taxi sector. Without action, Zambia's 2030 road safety targets will remain out of reach.

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DRAFT

Space for cycling: initial field study results

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Abstract

Bicycle riders and potential riders may not feel, or be, objectively safe, as a result of bicycle riding infrastructure such as paths and lanes not meeting user needs. In 2024 cyclists accounted for 17% of hospitalised injuries and 3% of deaths on Australian roads (BITRE 2024). This research aims to determine an adequate amount of space for cycling, compare it to standards, and understand the safety implications of the results. Through naturalistic observation, this field study (n=1032) finds that 20% of Australian riders use a wider tracking width, and 10% a wider operating width, than guidance allows. The data also reveal that if more space is given, it gets used by wider tracking width and vehicles. These preliminary results conclude that more space is needed for safer cycling, and future analysis can provide direct input into policy and practice, especially design guidance.

Introduction

If a vehicle does not fit on designated infrastructure, we can expect inconvenience in the form of re-routing, encroachment into other spaces, and an increased likelihood of crashes when objects collide. By following guidance, road designers can provide a large truck with enough space to safely turn, but how much space does it take to ride a bicycle? This is complex and poorly understood; existing studies tend to examine isolated aspects of the bicycle dynamic envelope (Napper et.al., 2026) and guidance such as in Figure 1 is silent on some aspects of cycling such as cornering and rider skill.

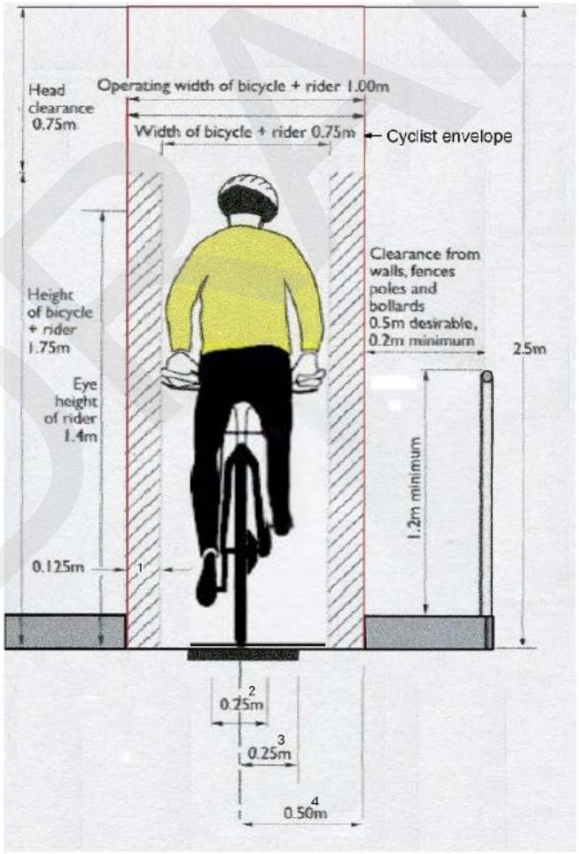

Figure 1. Current Australasian guidance on the dynamic envelope for cycling (Austroads, 2017).

In this study I take a sociotechnical perspective. This perspective brings together how things work (technical) with their acceptance (social) by individuals, cultures and society in general. Space for cycling in low-cycling places like Australia also includes a political dimension as a subset of the social aspects. From a road safety perspective, notable social aspects of cycling include the cycling ability of the rider when factoring in variables such as skill or fatigue. These are poorly understood because of the dominant technical perspective.

Starting with the technical perspective, (bi)cycles come in many forms, dominated by two-wheeled single-track vehicles that are balanced by the rider. A scoping review of recent evidence suggests that the technical minimum is a spatial envelope 1.5m wide, 2.5m tall, and a 1 second headway between vehicles (Napper et.al., 2026) which is at odds with figure 1. Socially the subject is much more complex because of variation in habits, cultures, behaviours, risk aversion and vehicle types to name a few. This research compares guidance to reality by focussing on:

1. **Tracking width**. An amount of side-to-side motion is found as a rider balances by "steering into a fall" (Wilson and Schmidt. 2020). In this process the rider traces a wave-type path, tracking width is the maximum amplitude of this wave measured over 10m. Australasian guidance, summarised in figure 1(note 2) provides a dimension of 250mm.
2. **Width of the whole vehicle**, made up of a combination of bicycle, rider, and other items such as passengers, shopping or luggage. Measured at the widest point. Australasian guidance is 750mm.
3. **Operating width**. The sum of tracking and vehicle width.

Conference theme

This work provides preliminary findings of an ongoing field study into the dynamic envelope of cycling, a field of work where little evidence exists. Findings are drawn for how this evidence builds towards the action of defining safe spatial envelopes for cycling, so that bicycle riding may have a bright (safer) future.

Method

A naturalistic observation method is used, whereby data shown in table 1 are collected by means of ethically approved covert stereo-videorecording using a spatial grid of 50mm interval. Subjects are recorded undertaking cycling activities and then videos are compiled into a single source for analysis (Figure 2). Riders are measured over a 10m long grid, as wide as the infrastructure being recorded, and 2m high. Data are coded manually from the video source into a database. For this study N=1032 of which 627 riders are in Australia, and 405 are in the Netherlands. All samples are straight paths. A small number of data points are missing because of visual obstructions.

A researcher is present during all recording sessions, prepared with explanatory statement and the ability to delete recordings upon request. So far 1/1032 observations have resulted in a participant stopping to ask questions. No concerns have been raised.

Findings

Descriptive statistics are provided in Table 1, separated for Australia and Netherlands.

Table 1. Descriptive statistics of finds by country.

Country		Tracking Width	Vehicle Width	Operating Width	Lane Width
Australia	Mean	201.37	602.10	796.89	1368.42
	N	627	620	625	627
	Std. D	216.030	78.166	242.062	148.661
Netherlands	Mean	254.20	640.13	886.42	1978.42
	N	405	400	405	405
	Std. D	219.094	88.902	251.851	60.362
Total	Mean	222.10	617.01	832.10	1607.81
	N	1032	1020	1030	1032
	Std. D	218.660	84.566	249.699	321.951

Results reveal a wide range of tracking width values over the 10m long measurement grid. While 200 riders had a tracking width of near zero over 10m, the 50th percentile tracking width was 200mm. Distribution was not normal, with 75th percentile tracking width being 300mm, and the 95th percentile 700mm. In this sample only half of the riders maintained a tracking width equal to or less than the figure provided in the road design guidance. 75 (8%) of Australian riders tracked wider than the guidance of 1.0m.

The total sample contained 50 (5%) vehicles wider than 750mm, 33 (3%) of these were in the Netherlands sample. Many riders operate under the 1m described in guidance, however the 75th percentile operating width was found to be 950mm. The 95th percentile is 1300mm. A substantial number of present bicycle users are operating in a larger lateral operating width than guidance recommends. Looking at the Australian riders, 61 (10%) of cyclists exceed the guidance's operating width.

The Netherlands sample was taken on wider infrastructure. Interestingly, 102 (25%) of riders in the Netherlands exceeded a 1m operating width. Pearson's correlations with the lane width are 0.218 for vehicle width; 0.074 for tracking width; and 0.138 for operating width. Causality is a complex sociotechnical matter, but it appears that wider paths correlate with wider vehicles and riding styles.

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Figure 2. Still from compiled video used for coding showing an improvised transverse tandem quadricycle in Utrecht, Netherlands.

Benefits to road safety

Findings of this research show that cycling is more variable than guidance would have us understand, and the manner in which bicycle riders move is not well understood. This has the effect of built infrastructure being below a minimum threshold for safe cycling, based on a sample of those people who are already using a bicycle. An evidence base is provided that can underwrite the creation of safer infrastructure by removing material conflicts in space.

Implications for policy and/or practice

Adequate space for cycling takes on different forms. This study only records people who are riding, however shows that when more space is provided, different cycling trips emerge and broader demographics are served. Findings suggest that guidance on road design for safe cycling is lacking. Improving safety for those already using bicycles could be achieved by increasing space, removing or reducing mechanical conflicts such as colliding with static objects or other road/path users. People who choose not to cycle may find it a more acceptable mode if this space is expanded to be adequate for them.

All levels of government in Australia intend to grow cycling mode share, however the provision to do so is limited in many places. More analysis is required, but the findings suggest that if more space is provided, it gets used. Wider paths could be an avenue to attract more people to cycle and enhance the safety of those who already do. Perceived safety is a known barrier to behaviour change to cycling. By developing better knowledge, and road design guidance, we may be able to build better cycling infrastructure. The field work and analysis underpinning this research is ongoing.

Conclusions

Findings of this research so far suggest that some built infrastructure in Australia is below a minimum technical threshold for safe cycling. In particular for the Australian sample, 8% of Australian riders exceed an operating width of 1.0m.

This study is ongoing, but so far shows that the guidance dimensions of bicycle and rider do not represent the real world dynamic envelope of these vehicles, and that an expanded envelope of space may be necessary to enhance safety, reduce injury, and accommodate the variety of trips, (bi)cycles, skill levels, cargo and social needs that riders, and potential riders, may have. Future work will expand the database range, investigate curves and corners, and provide a larger basis for analysis.

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DRAFT

Driver preferences for transparency cues in automated driving

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Abstract
Most commercially available automated driving systems communicate binary on/off states, without revealing when systems may be approaching the limits of their capability. This can leave drivers poorly prepared to safely resume vehicle control. Transparency cues have been proposed to make the internal states evident to drivers, communicating information that concerns the system's confidence in its ability to manage the driving task. How drivers themselves want this information delivered is a question in need of direct investigation. Fifteen Australian drivers participated in semi-structured interviews examining preferences as to how automated driving systems should communicate declining internal capability. The analysis revealed design themes (continuous versus event-triggered feedback, causal versus diagnostic detail, and visual versus auditory modality allocation), alongside an emergent theme, sustained cue credibility, capturing conditions under which cues maintain influence across repeated exposure. These findings produced two competing transparency cue designs to support driver preparation for vehicle control transitions.

Introduction
Automated Driving Systems (ADS) fundamentally shift the driver's role from active vehicle control to supervisory monitoring (Merat et al., 2019). This shift creates conditions where drivers become "out-of-the-loop," a state characterised by diminished awareness of, and involvement in, the driving environment (Merat et al., 2019). When drivers operate in this state, their ability to resume control safely is compromised. In a simulator study examining 753 takeover situations, drivers required 2-3 seconds to begin steering after a takeover request, with many requiring over 5 seconds to stabilise the vehicle (Gold et al., 2018). These delays are compounded when drivers do not understand the conditions under which the system will fail. In a driving simulator study, drivers who did not understand the limitations of an adaptive cruise control system were slower to recognise when the system failed to detect a hazard. This left them less distance to respond and, in several cases, resulted in collisions (Gaspar et al., 2021).

Transparency cues have been proposed to address this deficit by communicating information about a system's current capability, enabling drivers to calibrate their understanding to actual system performance (Bhaskara et al., 2020). Existing transparency designs, such as probability displays, confidence bars, and two-dimensional certainty trendlines, have been developed primarily from theoretical frameworks, with driver perspectives sought through post-experiment evaluations (George et al., 2026). What remains unclear is how drivers themselves believe automated systems should communicate declining capability, and whether they want such communication at all. Addressing this question requires resolving competing demands: whether feedback should be continuous or triggered only when system confidence changes, how much causal detail to communicate under time pressure, and how to allocate information across visual and auditory channels. These tensions have not been directly examined from the driver's perspective. This study uses a collaborative co-design approach to establish driver preferences before prototype development, applying Nielsen's (1994) usability heuristics as an analytical framework to map those preferences onto established interface design principles.

Conference Theme
This work addresses the ARSC2026 theme *From Evidence to Action* by translating driver preferences into actionable design principles and a testable transparency cue system. Rather than evaluating existing interfaces, this study captures driver needs before a prototype is developed, positioning user requirements as the foundation for interface design.

Method
Fifteen drivers (6 female and 9 male; aged 18–59 years) holding valid Australian driver's licences participated in semi-structured interviews conducted online. Participants were recruited through university research participation systems and online driving communities. The Macquarie University Human Research Ethics Committee approved the study (Ref No. 520251940864572), and all participants gave informed consent. Driving experience ranged from 1 to 40 years, with varying levels of exposure to adaptive cruise control and lane-keeping assistance. The interview followed a funnel approach, moving from general experiences with automation, through a standardised scenario depicting situations of degraded system confidence (faded lane markings, heavy rain, changed road surface), to specific preferences regarding how system confidence should be communicated to drivers. A hybrid thematic analysis applied Nielsen's (1994) usability heuristics as a deductive framework while remaining open to emergent themes. Two coders established reliability on a subset of transcripts, achieving a Cohen's kappa of 0.78, indicating substantial agreement. Segments extending beyond the deductive framework were examined inductively.

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Findings

The analysis generated 230 coded segments across the ten usability heuristics. The hybrid analysis identified three design tensions as themes reflecting competing driver preferences that any transparency implementation must resolve, alongside an emergent theme capturing conditions under which cues maintain influence across repeated exposure.

Theme 1: Continuous versus event-triggered feedback. Participants disagreed about whether transparency cues should always be visible or only when confidence is degraded. Some preferred a constant baseline display confirming normal operation, reasoning that persistent visibility would support ongoing awareness of the system state. Others considered persistent displays unnecessary during stable conditions and wanted cues to appear only when something changed, with most also converging on traffic light analogies as their preferred format. This tension reflects a trade-off between sustaining driver engagement and preventing information overload.

Theme 2: Causal versus diagnostic detail. Participants reported wanting to know why confidence was degrading. Generic messages such as "trouble detected" were criticised for providing no basis for anticipatory action. At the same time, participants emphasised that explanations needed to be brief and immediately interpretable, particularly under time pressure when cognitive resources are most constrained. The tension lies in communicating enough causal information to support decision-making without increasing cognitive load at the moment drivers can least afford it.

Theme 3: Visual versus auditory modality allocation. Participants described distinct roles for visual and auditory channels. Visual displays were preferred for communicating the degree of confidence through graduated indicators such as colour changes or bars. Auditory cues were preferred for time-critical alerts where the driver's eyes might be diverted from the instrument cluster. Several participants wanted spatial mapping of audio to the relevant direction of a hazard. These preferences suggest that modality selection should be driven by the type and urgency of the information, rather than applied uniformly across all system states.

Emergent Theme: Sustained Cue Credibility. Participants described cues losing credibility through three mechanisms: accuracy (the cue not corresponding to actual driving conditions), discriminability (the cue becoming indistinguishable from baseline displays or other alerts), and verifiability (attending to the cue carrying no consequence). These conditions operated cumulatively, and participants described these failures not as isolated annoyances, but instead as experiences that shaped how they responded to feedback from other in-vehicle systems.

Resulting Designs. The findings produced two competing transparency cue designs. Figure 1 shows a three-tier categorical system. Figure 2 shows a continuous trendline displaying system confidence in real time. Both designs use the traffic-light colours and operate on a path to system disengagement. The key difference is that the categorical display shows three discrete states with no additional levels of information to interpret. The trendline utilises a continuously updating display that reveals more precise confidence levels than named states can convey. These designs are intended to address the tension over how much information the system should communicate to the driver.

Figure 1. (a) Autopilot Engaged. (b) Confidence Reduced. (c) Take Over Now.

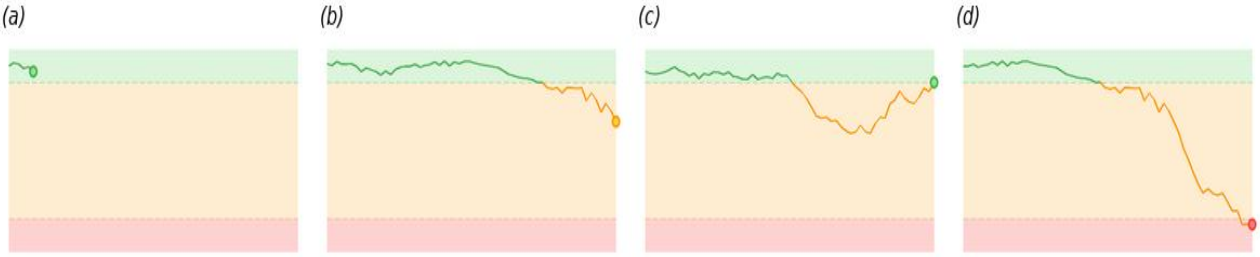

Figure 2. (a) Autopilot Engaged. (b) Confidence Reduced. (c) Autopilot Re-Engaged. (d) Take Over Now.

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Benefits to Road Safety

These findings extend warning design principles to automated driving by providing driver-centred evidence as to how transparency cues should be timed, structured, and communicated to support reliable takeover. Graduated transparency gives drivers a preparatory window to re-engage with the driving task before control transfer, rather than reacting to a disengagement that is already in progress. The credibility findings add a longitudinal dimension: cues that trigger without corresponding to real conditions, or that carry no consequence for being ignored, train drivers to disengage from the broader alert ecosystem, not only the offending system.

Implications for Policy and/or Practice

Existing international regulations for automated driving, including UN Regulation No. 157 (UNECE, 2021), require interface indicators for discrete system states, including activation, deactivation, system failure, and transition demands. These requirements do not extend to the communication of system capability between these states. Section 6.4.2.2 of R157 requires only a constant optical signal during regular operation, with no intermediate state before a transition demand is issued. In Australia, the proposed Automated Vehicle Safety Law would establish a general safety duty for automated driving system entities preparing for conditional deployment from 2026 (National Transport Commission, 2024), although how system capability should be communicated to drivers remains unspecified.

Conclusions

Three design tensions emerged from driver interviews: the timing of feedback (continuous versus event-triggered), the level of causal explanation (brief versus detailed), and the allocation of information across sensory channels (visual versus auditory). An emergent theme, sustained cue credibility, identified conditions under which cues retain influence across repeated exposure through accuracy, discriminability, and verifiability. Two transparency cue designs were developed to operationalise these findings. These stated preferences, drawn from fifteen Australian drivers, may differ from behaviour in real-world driving. Future research will evaluate these designs in a driving simulator to determine which best supports safe takeover.

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DRAFT

Evaluating child safety in LMIC context using SR4S Framework

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Abstract
Road crashes remain a leading cause of death and serious injury among children in Bangladesh. School-going children are at risk due to speeding, inadequate pedestrian facilities, weak enforcement, and limited awareness in schools. In this study, systematic field surveys, speed and traffic volume analysis, infrastructure inspection, and SR4S modelling are used to assess the current safety conditions of 5 schools in Bangladesh near highways and evaluate the impact of low-cost improvement measures. Results indicate that all schools were rated 1-Star (Least Safe) under existing conditions. Simulation of low-cost and moderate-cost countermeasures demonstrated the potential to improve safety outcomes to 3-Star (Moderately Safe) levels across all sites. The findings suggest that cost-effective interventions can reduce children's exposure to road danger although the improved ratings are modelled estimates rather than observed post-implementation crash or injury outcomes.

Introduction
Road traffic injuries are a major public health concern worldwide. Each year, more than 1.19 million deaths are estimated due to road traffic death while in low and middle-income countries, it accounts for nearly 92% of global fatalities (WHO, 2023). Children are often classified as vulnerable road users, however, their vulnerability is largely formed by road environments and traffic conditions that expose them to elevated levels of road danger, particularly where high traffic speeds, speed variation, inadequate pedestrian facilities and weak enforcement exist (Austroads, 2026; Gilbert & te Brömmelstroet, 2024).

In Bangladesh, the risk faced by children is disproportionately high. According to the police reported crash database, more than 3,000 people are killed each year in road traffic crashes in Bangladesh and approximately 21% of these fatalities are children (Afifa & Hossain 2016). The problem is further increased by rapid urbanisation, increasing motorisation, roadside activity, unawareness, lack of road sign-marking, absence of safe crossing facilities and traffic calming measures in school zones. Besides, inadequate pedestrian infrastructure combined with mixed traffic conditions increases the crash risk, particularly for vulnerable road users such as children (World Bank, 2018). In Bangladesh, rapid motorisation, mixed traffic conditions, and weak pedestrian infrastructure place school children at heightened risk, particularly during school start and dismissal periods.

School areas are particularly high-risk locations due to the combination of concentrated pedestrian movement and infrastructure quality, along with speeding. Children in rural areas experience greater exposure to unsafe road conditions, accounting for about 76% of fatalities compared with 24% in urban areas, while injury rates are also higher in rural settings than in urban areas (Afifah & Hossain, 2016). However, traditional road safety interventions in Bangladesh have often focused on isolated engineering measures or awareness campaigns without a systematic assessment of risk and effectiveness.

To address this gap, the Star Rating for Schools (SR4S) tool, developed by the International Road Assessment Programme (iRAP), provides an evidence-based framework to estimate and improve road safety around schools. SR4S evaluates road and roadside attributes such as vehicle speed, road geometry, pedestrian facilities, crossing provision, supervisor presence and traffic control, and translates these into a star rating (1-Star to 5-Star) that represents the level of safety for child pedestrians (Zayerzadeh & Zavareh 2019). The tool also allows practitioners to test combinations of countermeasures and estimate the potential improvement in safety outcomes before implementation. This study applies the SR4S methodology to selected schools in Bangladesh to quantify existing risk levels, identify critical safety deficiencies, and evaluate cost-effective interventions capable of achieving at least a 3-Star (moderate safety) standard.

By integrating local traffic data, infrastructure inspections, and SR4S modelling, the study aims to demonstrate how targeted, low-cost measures such as speed management, pedestrian crossings, signage, and school-zone treatments can potentially improve safety for children. The findings contribute to the data-driven approaches for achieving school road safety in low- and middle-income country contexts.

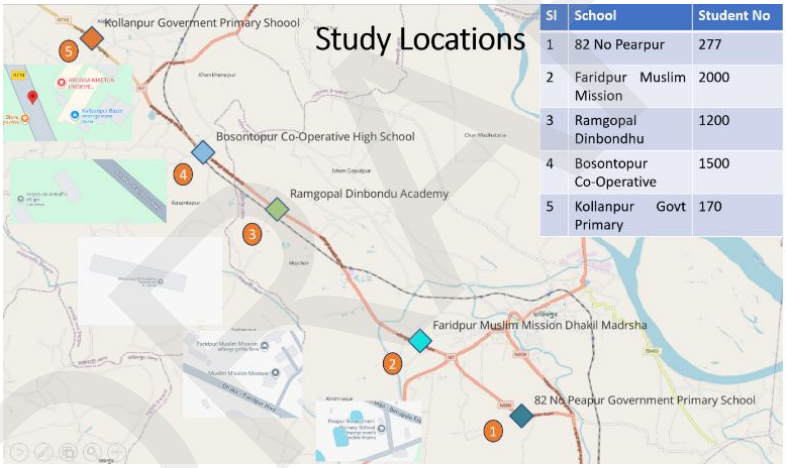
Conference theme

This study aligns with the ARSC 2026 theme by showing how evidence-based school-zone safety assessment can inform practical improvements for children in an LMIC context. Using the SR4S methodology, it provides a replicable pilot approach for identifying road risks around schools and testing potential safety improvements.

Method

For this study, five pilot schools located in two districts of Bangladesh such as Faridpur and Rajbari were selected based on traffic exposure, proximity to major roads, community engagement and student population. Among them, two primary schools and three high schools were identified and a prior discussion had been conducted with the school authority to understand the school catchment area and the available routes that are used by the students for school time. Besides, the assessment followed standard iRAP-SR4S guidelines and involved several sequential steps. Surveyors received training on SR4S indicators and data collection procedures and analyst received the certificate from iRAP on star rating for schools after completion of the online course. On 2 December 2025, field surveys were conducted to collect road geometry, pedestrian facilities, signage, markings, and surrounding land use. Speed studies measured operating speeds along school frontages as operating speed is a key indicator of crash severity and widely used in safety assessment to estimate injury risk (WHO, 2017). Besides, traffic volume surveys captured vehicle flow and composition during typical school hours, along with other related information.

Key SR4S inputs included observed operating speed, traffic volume and vehicle composition, road geometry, sidewalk and crossing availability and quality, school-zone signs and markings, traffic-calming facilities, intersection conditions, roadside activity and supervisor presence. The validated data were analysed using the SR4S-Demonstrator to generate current star ratings for each school zone. Low-cost countermeasures, including speed reduction, pedestrian crossings, short sidewalks, signage and traffic calming, were then tested as modelled improvement scenarios to assess whether each school zone could achieve at least a 3-Star rating. These scenarios assumed that the proposed treatments were implemented and functioning as coded in the SR4S-Demonstrator.



Sl	School	Student No
1	82 No Pearpur	277
2	Faridpur Muslim Mission	2000
3	Ramgopal Dinbondhu	1200
4	Bosontopur Co-Operative	1500
5	Kollanpur Govt Primary	170

Figure 1. Locations, school type and the number of students in the schools
Source: Open Street Map by QGIS. Schools are marked and titled by the authors using QGIS

Results

The SR4S analysis rated all five schools as 1-Star under existing conditions, mainly due to operating speeds of 40-50 km/h, missing or poor sidewalks and crossings, unauthorised parking, limited supervision and inadequate school-zone signage. Pedestrian movement along the road was the highest risk component across the sites. Site specific countermeasures were then tested as modelled scenarios, including speed management, marked or raised crossings, basic sidewalks, school warning signs and supervisor presence. The modelled results indicate that speed reduction, sidewalk provision and improved crossing facilities contributed most to the 3-Star improvements. Table 1 summarises the selected countermeasures by cost category.

Following the modelled application of these measures, all schools achieved the estimated ratings of approximately 3-Star, representing moderately safe conditions.. Accroding to the SR4S methodology, 3-Star rating is significant since 3-Star or better is the minimum target level for safer school journeys. Higher star ratings reflect improved protection from serious road trauma through speed reduction, safer crossing, enhanced pedestrian facilities and reduced exposure to high-risk vehicle-pedestrian conflicts (iRAP, 2021). Therefore, the simulated improvements indicate a potential reduction in children's exposure to road danger and a safer road for children. Table 2 illustrates the details of the transformation of the star rating scores after improvement.

Table 1. List of countermeasures and classification on cost and effectiveness

Sl.	Safety Measure	Cost Type	Effectiveness	Remarks
1	Supervisor Presence	No	Quick Wins	Immediate impact
2	Speed Limit (40kmph or low)	No	Quick Wins	Administrative action
3	Operating Speed Control	No	Quick Wins	Requires support from local authorities
4	Line and Sign	Low	Quick Wins	Strong visual guidance for drivers
5	School Warning Sign	Low	Quick Wins	Essential school zone identification
6	Marked crossing	Low	Quick Wins	Immediate pedestrian safety
7	Crossing Quality	Low	Quick Wins	Enhances driver compliance
8	Intersection Improvement	Low	Quick Wins	Improves visibility and awareness
9	Curve (Sign & Marking)	Low	Quick Wins	Warning for drivers
10	Speed Management	Low	Core Safety	Physical measures to reduce speed
11	Both sides sidewalk ≥100 m)	Moderate	Core Safety	Reduces pedestrian-vehicle conflict
12	Speed Humps (Minor Roads)	Moderate	Core Safety	Self-enforcing speed control

Table 2. Comparative analysis of the current and improved star rating of 5 schools

Location		Star ratings									
Sl	School Name	Before	Current			Total	After	Improved			Total
			Along the Road	Crossing				Along the Road	Crossing		
				Main Road	Side Road				Main Road	Side Road	
1	82 No Peapur Primary School	1	933.8	116.3	101.4	1151.5	3.3	7.8	7.3	3.8	18.9
2	Faridpur Muslim Mission	1	468.8	129.4	0	598.2	3.2	11.3	9.3	0	20.6
3	Ramgopal Academy	1	624.4	322.7	228	1175.1	3	5.8	10.1	7.1	23
4	Bosontopur High School	1	204.3	128.3	0	332.6	3.1	5.9	15.4	0	21.3
5	Kollanpur Primary School	1	301.1	87	0	388.1	3.4	6.3	10.9	0	17.2

Benefits to road safety

This work provides modelled evidence of how school-zone infrastructure risk can be systematically assessed and potentially reduced using the SR4S tool. Previous iRAP research demonstrated that higher star ratings are associated with safer road environments and lower exposure to fatal and serious injury risk. The findings therefore illustrate how relatively low-cost interventions can improve the level of protection available to children travelling to and from school.

Implications for policy and/or practice

The findings would support the integration of data-driven school-zone safety assessments into local and national road safety planning. Policymakers can adopt SR4S-based evaluations to prioritise investments, particularly in low-resource settings where cost-effective treatments are essential. For practitioners, the study provides a replicable model for data-driven decision-making, demonstrating how speed management, pedestrian infrastructure, and traffic calming measures can be strategically implemented to reduce crash risk. The results reinforce the need for coordinated action among schools, local authorities, and road safety agencies to systematically improve child road safety outcomes.

Conclusions

The transition from 1-Star to 3-Star modelled safety conditions suggests meaningful child road safety improvements are achievable through low-cost measures. However, as this pilot study is based on five purposively selected schools and depends on SR4S modelled outputs, the findings represent potential infrastructure-risk reductions rather than observed crash or injury reductions.

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DRAFT

Attitudes towards and demand for safe speeds across NSW

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Abstract
This study used a survey across four regional and three metropolitan NSW LGAs (n = 903) and introduced a novel measure of community demand for safe speed, adapted from the Shared Concerns subscale of the Community Mobilisation Scale. Regional differences were found in willingness to speed and attitudes toward safe speed, but demand for safe speed was generally neutral and did not vary by region. Both willingness to speed and attitudes to safe speed individually predicted demand, but attitudes to safe speed was the stronger predictor. These findings suggest traditional speeding attitudinal measures may not capture this emerging construct of shared concern about/public demand for safe speeds and highlight the need to build stronger community concern for speeding to support effective speed-management policy and practice.

Introduction
A safe road system requires all speed limits to be set appropriately for the road environment and mix of road users, and these limits to be complied with by all. Despite extensive evidence linking speed to crash risk and injury severity, speeding remains a major contributing factor to crashes. In New South Wales (NSW), speeding contributes to approximately 42% of deaths and 25% of serious injuries on the roads (Transport NSW, 2025), and non-compliance with speed limits remains a prominent challenge. Various speed enforcement interventions help address speed limit compliance and reduce crashes (Soole et al., 2013). However, their long-term effectiveness is likely to depend on community recognition of their value, and importantly, on public demand for all interventions aimed at managing speeds. Speed management remains a politically sensitive topic, yet political support is critical to developing and implementing speed management strategies (Turner et al., 2024). This support is more likely to occur if there is community pressure and demand for action. However, little is known about community demand for safe speeds, how to measure it, and its relationship with community attitudes to speed. These gaps need attention because understanding the extent to which the community demands safe speeds is essential to development and long-term effectiveness of speed management interventions.

There is evidence that community attitudes to speed vary across different geographical regions (Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts, 2018; Queensland Government, 2024), but despite differences in socioeconomics, road environments, travel behaviours and the contribution to the burden of traffic injury between metropolitan and regional areas in Australia, attitudes to speeding are often not directly disaggregated across these geographical distinctions (e.g. NSW Centre for Road Safety, 2024). Furthermore, there is no understanding about how demand for safe speed might vary across regions. To address these gaps, this research used a community-wide online survey, conducted as part of a larger study, to investigate attitudes toward speeding and the extent of community demand for safe speed across different areas in NSW; and the relationship between community attitudes and demand.

Conference theme
This study presents new evidence about the extent of community demand for safe speed across different NSW contexts, and the relationship between community attitudes towards and demands for safe speed. Speed is still a major contributor to fatal and serious injuries crashes and this research assists in determining the relative sense of urgency the community holds for speed-related issues, and directly addresses gaps in understanding required for effectively educating and persuading the community about this important road safety issue. This new evidence is essential to facilitating effective action to achieve a truly safe road system.

Method
Data presented here comes from baseline data collected during a larger project[1] examining potential of participatory methods to increase public demand for safer speeds. Baseline online community-wide surveys were conducted across the seven LGAs (Metropolitan: City of Sydney, Canterbury Bankstown Council, City of Ryde; Regional: Mid-Western Regional Council, Port Stephens Council City of Coffs Harbour, and Parkes Shire) to capture community attitudes to and engagement with speeding and speeding-related concerns.

[1] Funded by the Australian Government through the Department of Infrastructure, Transport, Regional Development, Communications and the Arts.

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Participants were aged 18 years or older who live or work in one of the seven participating LGAs, with ability to complete the survey in English. In addition to collecting demographic details, the survey was designed to collect data on attitudes towards and demand for safe speed (See Table 1). Safe speed attitude questions covered; 1) self-reported willingness to speed under various conditions and 2) self-reported attitudes towards safe speed. For 'demand for safe speed' we used questions adapted from the Shared Concerns subscale of the Community Mobilisation Scale (Lippman et al., 2016) to develop an initial quantitative measure of community demand for safe speeds, given this is a relatively new construct that has not yet been quantitatively assessed.

Table 1: Survey Items used to Construct Domains of Interest

Willingness to speed	Attitude to Safe Speed	Demand for Safe Speed
To keep up with the flow of other traffic?	Driving above the speed limit is okay if you're a good driver	People in my local area are concerned about speeding
When there are no pedestrians around?	Speed limits around here are set at the right level.	People in my local area consider safe speeds an important issue
When you are tired?	Lower speed limits mean it will take me at lot longer to get where I need to go.	People in my local area talk about the need for safe speeds at community gatherings
When you are unfamiliar with the road?	The main purpose of speed cameras is to raise revenue for the government	People in my local area believe that speeding impacts the community in a negative way
When you are familiar with the road?	Speeding is of less risk to the community than drink driving.	People in my local area talk openly about the need for safe driving speeds
When you believe there is no risk of being caught by police?	Reducing speed limits would make a significant difference to reducing road trauma.	People in my local area work together to encourage safe travel speeds
When you consider it is safe to do so?	We should all drive within the speed limits, no matter when it is or where we are	People in my local area work together to reduce the impact of speeding
When there is not much other traffic on the road?	Enforcing speed limits is a good way to keep our community safe	People in my community share information about the risks of speeding
When you are running late?	Local government initiatives are important for improving safety on our local roads	People in my local area believe they can change the way the community thinks about safe travel speeds
	Modern vehicles make it safe to travel faster than the speed limit	People in my local area take the risks posed by speeding seriously

All attitude and demand items were assessed using a Likert Scale consisting of four, five or six response options. Cronbach's alphas were calculated for each block of questions. If internal consistency was acceptable ($\alpha \geq 0.70$), the Likert items were summed into a composite score. Scales were examined and items were reverse coded where necessary to ensure consistent interpretation. Descriptive statistics were produced for demographic characteristics and community attitudes towards and demand for safe speeds across the entire sample and by metropolitan and rural regions. Independent t-tests were used to test for significant differences in attitudes and demand for safe speed between regions. Linear regression was used to examine the relationship between the different safe speed attitude domains and demand for safe speed. All analyses were conducted using the R statistical package (R Core Team, 2024). The study was approved by UNSW's Human Research Ethics Committee.

Results

A total of 903 participants completed the survey (metropolitan = 411, regional = 492). Across this sample, the mean age was 52.5 years (SD=6.93; range: 18 - 85 years) with no significant difference between regions. More females from regional LGAs (61.7%) completed the survey compared to metropolitan LGAs (59.7%) but the difference was not significant (p=0.58). Those living in regional areas were significantly more likely to have held a full car licence for at least 10 years (96.5% vs. 86.1%; p<0.001) and to drive every day (65.2% vs. 37.7%; p<0.001) compared to metropolitan participants.

Willingness to Speed (maximum score of 54; higher scores = greater willingness to speed; Cronbach's $\alpha = 0.94$) was significantly lower in metropolitan compared to regional areas (SE = 0.57, $t(901) = -2.22$, $p = 0.027$), although willingness to speed was generally low (Total sample: M= 18.77, SD=8.49, Range: 0 - 45; Regional: M=19.34, SD=8.63 and Metropolitan: M=18.09, SD=8.29). For Attitude to Safe Speed (maximum score of 50; higher scores = less favourable attitudes towards safe speed; Cronbach's $\alpha = 0.79$), regional participants held significantly less favourable attitudes than metropolitan participants (SE 0.44, $t(901) = -3.99$, $p < 0.001$). However, participants overall held generally neutral attitudes (Total sample: M= 24.50, SD= 6.57, Range= 10 - 48; Regional: M= 25.29, SD=7.05 and Metropolitan: M= 23.55, SD=5.83). Community demand (maximum score of 50, higher scores = greater demand for safe speeds; Cronbach's $\alpha = 0.92$) was not significantly different between regions (SE 0.53, $t(901) = 1.39$, p=0.17), with

participants reporting relatively neutral levels of demand (Total sample: M= 29.14, SD= 7.89, Range= 0-50; Regional: M= 28.81, SD 7.54 and Metropolitan: M= 29.53, SD 8.27).

The Willingness to Speed and Attitude to Safe Speed domains were significantly associated with Demand for Safe Speed when examined individually (B = -0.142, 95% CI -0.202 to -0.082, $p < .001$; and B = -0.286, 95% CI -0.359 to -0.214, $p < .001$, respectively). However, when both attitude domains were entered into the same regression model, only Attitude to Safe Speed remained a significant predictor of demand (B = -0.268, 95% CI -0.353 to -0.183, $p < .001$). This indicates that the association between Willingness to Speed and Demand for Safe Speed is largely shared with Attitude to Safe Speed, which accounts for the unique variance in the outcome. Overall, this suggests that the Attitude to Safe Speed domain is the stronger and more independent predictor of Demand for Safe Speed, with more favourable Attitudes to Safe Speed indicating greater Demand for Safe Speed.

Benefits to road safety

This research demonstrates similarities and differences between metropolitan and regional NSW communities in their attitudes toward safe speeds and willingness to speed, along with a novel assessment of public demand for safe speeds based on the concept of community-level concern. Although this approach needs further validation, findings suggest that separate measures of attitudes and demand for safe speed may be needed, as traditional attitude-to-speeding constructs may not adequately capture this emerging concept. The regional differences identified may help inform future speed-management interventions better reflecting local contexts.

Implications for policy and/or practice

Our findings may help policymakers make decisions that better reflect the community's attitudes towards safe speeds, especially in regional LGAs where participants held less favourable attitudes towards safe speeds and reported greater willingness to speed. The low level of demand for safe speed across the NSW community highlights the need for action to reverse this. For practitioners, new understanding generated from this work may help guide more effective communication on safe speeds. This work also represents the first attempt to measure demand for safe speed and may inform design of initiatives aimed at raising demand for safe speeds.

Conclusions

While willingness to speed and attitudes toward safe speed varied by region, overall levels of community demand for safe speeds were neutral and did not vary. Both willingness to speed and attitudes toward safe speed were associated with demand, but the latter emerged as the stronger predictor. However, the reliability and validity of the measure for demand remains unclear, as developed a novel scale that has not been quantitatively validated. Nonetheless, these findings highlight that traditional attitude-to-speeding measures may not fully capture the emerging construct of community demand for safe speeds, suggesting a need for refined and validated measures. The generally low demand observed indicates substantial opportunity to strengthen community recognition of the importance of safe speeds.

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DRAFT

School Zone Safety in LMICs: a data-driven participatory framework

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Abstract
Road traffic crashes are a leading cause of death among youth in low- and middle-income countries (LMICs). This study presents a scalable school-zone safety framework implemented in Vietnam that seeks to bridge the “evidence-to-action” gap through multi-sector collaboration and youth participation. The approach integrates large-scale data screening of approximately 26,000 schools with community-level risk perceptions collected through a Youth Engagement App (YEA). Youth participants contribute local knowledge by mapping road hazards and reporting safety concerns around their schools. These data are combined with objective engineering assessments using the Star Rating for Schools (SR4S) methodology. During the pilot phase, 89 infrastructure improvements were implemented across 22 schools following the identification of high-risk locations. National expansion subsequently prioritised the 500 highest-risk school zones and supported formal commitments from local authorities to upgrade at least 28 locations. The findings suggest that integrating large-scale data analysis with participatory approaches can support more effective prioritisation of school-zone infrastructure improvements. The framework offers a transferable model for strengthening data-driven road safety governance in LMICs.

Introduction
Road traffic injuries claim roughly 1.19 million lives each year, standing as the leading cause of death for children and youth aged 5–29. Approximately 92% of these fatalities occur in LMICs, highlighting significant inequalities in road safety outcomes (WHO, 2023).

Achieving the 2030 target to halve road trauma in LMICs requires shifting from merely trying to "fix the road user" to adopting a holistic "fix the system" approach (Tavakkoli et al., 2022). However, operationalising this systemic perspective remains challenging in many LMIC contexts. Two key barriers frequently emerge: limited access to reliable data to support evidence-based decision-making (Tavakkoli et al., 2022), and insufficient coordination among government agencies and stakeholders (WHO, 2023).

Although the Global Plan for the Decade of Action for Road Safety 2021–2030 recognises young people as important stakeholders, youth participation in transport planning processes remains limited (ITF, 2024). This absence is particularly problematic in school environments, where students are among the most frequent road users. Without local insights from these users, decision-makers may rely solely on technical assessments that do not fully capture everyday safety risks.

This study addresses the gap between technical evidence and implementation by presenting a school road infrastructure risk assessment framework developed and implemented in Vietnam. Drawing on pilot phase findings (2021–2024) and preliminary results from the scaling phase (2024–2027), the framework combines large-scale data analysis, engineering risk assessment, and youth-generated perception data collected through YEA. The objective is to demonstrate how integrating technical analysis with participatory approaches can support more effective prioritisation of school-zone safety interventions.

Conference theme
By converting rigorous Big Data analysis and youth-sourced risk perceptions into targeted infrastructure interventions through multi-stakeholder collaboration, this study demonstrates that evidence paired with meaningful partnership becomes the foundation for safer school journeys, first in Vietnam and as a scalable model for a brighter future for young commuters across LMICs.

Method
The proposed framework integrates technological tools with structured multi-stakeholder collaboration to support evidence-based decision-making in school-zone safety management.

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Data-Driven Risk Identification

- **Big Data Screening:** Integrating big data into safety management optimises resource allocation and efficiently informs decision-making (Wang & Wang, 2021). By leveraging AI and satellite imagery, nationwide road and traffic attributes were processed generated a ranked list of locations based on estimated road safety risk, allowing authorities to prioritise sites for further assessment while reducing the cost of extensive field data collection.
- **YEA:** Students utilised YEA to document road hazards and report safety concerns in their surrounding environments. These user-generated data provided contextual insights into everyday road risks experienced by students during their journeys to and from school.
- **SR4S:** Locations pinpointed by Big Data and YEA user data underwent objective engineering assessments using the SR4S tool to determine specific infrastructure conditions and recommends appropriate countermeasures to improve safety.

Together, these three tools form a multi-stage data funnel that integrates large-scale risk screening with local knowledge and technical assessment.

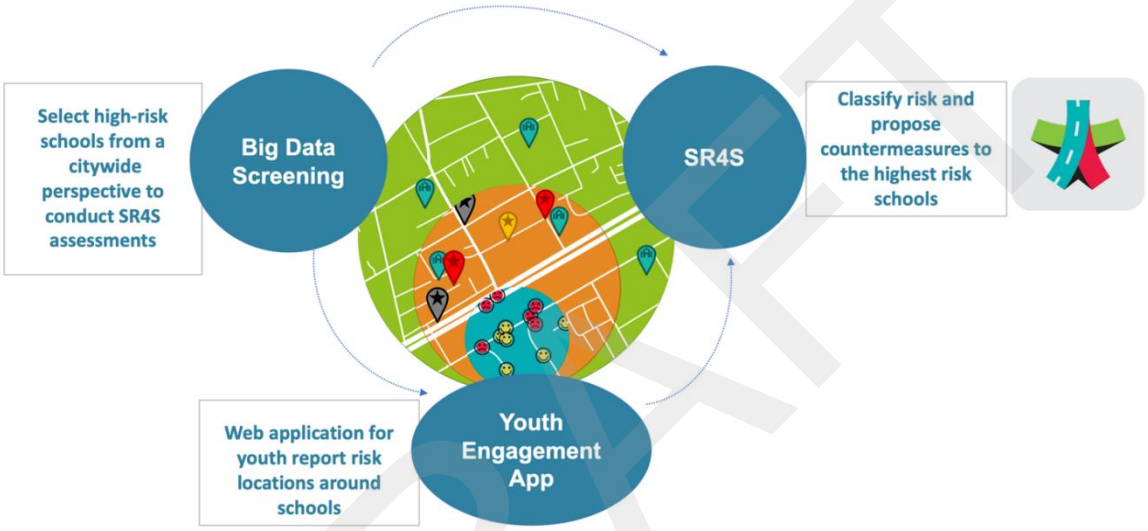

Figure 1. Integrated digital tools for school-zone risk identification
Source: AI&ME: Empowering Youth for Safer Roads Scalability Analysis Report

Multi-Stakeholder Governance Framework

The framework incorporates youth participation within a structured multi-sector governance model. While traditional youth involvement often stalls at the level of "Tokenism" (informing or consultation) (Arnstein, 1969), this model aims to position youth as active contributors within decision-making processes by incorporating their data and perspectives into technical assessments and policy discussions.

Implementation involves collaboration among five key actors:

- **International donors** provided financial support.
- **Technical partners** developed data analysis systems.
- **Coordinating NGOs** coordinated implementation activities.
- **Government** bodies overseed infrastructure planning and policy integration.
- **Youth** contributed local risk data and advocacy.

This collaborative structure aims to translate community-level insights into policy discussions and infrastructure planning processes.

Findings

The collaborative framework successfully bridged the gap between theoretical risk assessment and practical policy action.

During the pilot phase (2021–2024), Big Data and artificial intelligence were used to screen more than 1,000 schools across three Vietnamese cities including Ho Chi Minh City, Pleiku, and Yen Bai, ranking school zones from highest to

lowest risk and identifying 106 high-risk school areas. Complementing this macro-level analysis, 1,800 students from the identified high-risk schools used YEA to map road hazards around their schools, generating community-based perception data while strengthening youth participation in local road safety governance. Locations with the highest safety concerns reported by students were then assessed using SR4S methodology to analyse micro-level risks along specific road segments. Results showed that 98 of the 106 identified schools had 1–2 star safety ratings at their main entrances, where a 1-star rating represents the least safe and a 5-star rating the safest conditions. The integration of Big Data screening, youth-generated data through YEA, and SR4S assessments validated the risk model and informed evidence-based interventions, leading authorities to implement 89 infrastructure improvements across 22 schools.

Building on results from the pilot phase, the initiative expanded nationally (2024–2027). Big Data screening was conducted across approximately 26,000 schools nationwide, identifying 12 high-risk provinces and prioritising the 500 highest-risk school zones. This large-scale evidence supported targeted policy dialogue through national workshops and multi-stakeholder consultations, enabling government agencies to prioritise investments and integrate school road safety into infrastructure planning. Demonstrating the framework's effectiveness in translating data into political commitment, authorities in two priority provinces formally adopted the evidence and committed to upgrading infrastructure in at least 28 high-risk school zones.

Benefits to road safety

By analysing risk at scale, the initiative enables governments to allocate limited public resources where they are needed most, ensuring that life-saving infrastructure, such as raised crosswalks, pedestrian signals, and speed limit signage, is prioritised precisely where child pedestrian exposure is highest. Beyond physical improvements, elevating youth as active policy partners cultivates a generational culture of road safety awareness, embedding long-term behavioural change alongside structural intervention.

Implications for policy and/or practice

This study demonstrates the potential value of integrating large-scale data analysis with participatory data collection in road safety planning. The framework supports more systematic identification of high-risk locations while incorporating contextual insights from frequent road users.

From a governance perspective, the initiative illustrates how youth engagement can contribute to policy discussions when supported by structured partnerships and credible technical evidence. Youth-generated data alone may not influence infrastructure decisions; however, when integrated into formal assessment processes, such data can complement engineering analysis and strengthen the case for intervention.

The approach also provides practical advantages for resource allocation. In many LMICs, infrastructure budgets are limited and must be prioritised carefully. By identifying locations with both high technical risk and strong community concern, decision-makers can target investments more effectively. Although the results are promising, further evaluation will be necessary to assess the long-term safety impacts of implemented infrastructure measures and the sustainability of the governance model.

Conclusions

This study presents a participatory, data-driven framework for improving school-zone road safety in LMICs. By combining large-scale risk screening, engineering assessments, and youth-generated perception data, the approach provides a structured method for identifying and prioritising high-risk locations.

The results from Vietnam suggest that integrating technical analysis with community participation can help translate safety evidence into policy commitments and infrastructure improvements. The framework therefore offers a potentially transferable model for strengthening road safety planning in other LMIC contexts where data limitations and governance challenges remain significant.

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Extrication following a crash: learnings from in-depth crash investigation

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Abstract
Post-crash care is a critical yet often under-recognised component of the Safe System. The aim of this paper is to provide a profile of crashes involving extrication by emergency services in South Australia from 2014-2025. There were 49 crashes identified with 57 participants requiring extrication. There were 15 crashes in the Adelaide metro area which took on an average of 87 minutes from time of crash to hospital. There were 34 rural crashes which took an average of 157 minutes from time of crash to hospital. Over half of these occupants sustained serious injuries (MAIS 3+), with higher injury severity observed in rural crashes, particularly head-on and fixed-object collisions. These findings highlight the operational and clinical importance of extrication within trauma care and support improvements in emergency response, rural road safety measures, and technologies such as automated crash notification to reduce delays and improve outcomes following serious road crashes.

Introduction
Post-crash care represents a critical, yet frequently under-recognised, component of the Safe System framework. Within this pillar, vehicle extrication plays a pivotal role, as safe, patient-centred extrication practices can mitigate or prevent further clinical deterioration, exacerbation of existing injury or secondary injury following a crash. Extrication undertaken by emergency services is often a complex, time-sensitive, and resource-intensive process, requiring coordinated efforts across multiple agencies to safely remove the patient while maintaining the safety of responders and the broader community (Calland, 2005; Nutbeam et al., 2021; Stroop et al., 2019). The collection of hospital and injury data within in-depth crash investigation allows for a more detailed review of crashes that involved extrication to elucidate the characteristics of these crashes, the injury severity of involved occupants, and the operational factors that may influence prehospital timelines and patient outcomes.

Conference theme
Vehicle extrication is a critical element of post-crash care within road safety frameworks, even as crash prevention remains the overarching priority. Investigation into the factors associated with incidents requiring extrication, particularly those involving injury, entrapment, and time-critical rescue, is essential to strengthening the evidence base. Translating this evidence into targeted recommendations supports more effective prevention and response efforts, ultimately contributing to the reduction of fatal and serious injury outcomes. Saliently, this research also recognises the vital role emergency services play in reducing the burden of road trauma.

Method
The in-depth at-the-scene investigations of casualty crashes conducted by the Centre for Automotive Safety Research (CASR) in South Australia (SA) from 2014 to 2025 were analysed for crash-involved participants that required extrication by an emergency service provider. For detailed methodology of these investigations see Doecke, Thompson & Stokes (2020). The requirement of extrication was determined through review of the South Australian Ambulance Service (SAAS) case note summary (if available), and summary of hospital injury notes. The Maximum Abbreviated Injury Severity (MAIS) and Injury Severity Score (ISS) were calculated for each participant. In cases where the SAAS or hospital injury notes were suggestive but vague as to whether the participant was extricated, images of the crash-involved vehicles were viewed for signs of emergency service extrication (e.g., the vehicle roof was removed). Cases were excluded if the participant self-extricated or if extrication was performed by bystanders. Cases where participants were deceased on arrival of emergency services at-scene or prior to extrication were excluded from this analysis (but included if death occurred following extrication). Cases were reviewed to determine the possible reason for emergency services extrication based on the SAAS or hospital notes and categorised as either a medical reason (e.g., suspected injury or participant pain limited ability to self-extricate), entrapment (e.g., participant door/s would not open, uninjured leg trapped in footwell) or a combination of both.

Results
Data from in-depth crash investigations was available for 430 participants that were either hospital treated, hospital admitted, or suffered fatal injuries. There were 57 participants (13.3%), identified from 49 crashes, who were deemed to have required extrication by emergency services**.** Of these participants, 27 were male and 30 were female**.** Outcomes

included 11 treated in hospital without admission, 41 hospital admissions, and 5 fatalities following extrication**.** Most occupants requiring extrication were drivers (n=46)**,** with the remainder being passengers across other seating positions. The most common vehicle types involved were sedans (n=21)**,** followed by 4WD/SUVs (n=11) and hatchbacks (n=10).

Of the 57 participants, 10.5% (n=6) did not have any codable injuries and 57.9% (n=33) sustained MAIS 3+ injuries. Seventeen of these cases were a MAIS 3+ injury of the chest (e.g., multiple rib fractures) and 12 cases were a MAIS 3+ injury of the head or neck area (e.g., cerebral contusion or spinal cord injuries). One case involved a MAIS 4 injury of both the head/neck area (intercerebral haemorrhage) and chest area (large pneumothorax). Two cases involving MAIS 3 fracture injuries to the femur. One case involved MAIS 4 of the abdomen from mesenteric injuries. The MAIS 6 was the result of a complete spinal injury C3 and above with the participant being older than 65 years and opting for end of life care. Table 1 provides a breakdown of participants by possible reason for extrication. There were six cases where extrication was performed for a medical reason without any specified entrapment. The majority of these crashes (n=4) were the result of a rear end. In 23 cases it was suggested that entrapment was the main reason for extrication, which is reflected in the lower average MAIS and ISS. Right turn crashes (n=6), rear end (n=5) and hit fixed object (n=5) were the main crash types for entrapment only. There were 28 cases where there was entrapment as well as an injury requiring medical intervention. These cases had a lower average Glasgow Coma Scale at scene (10.5) compared to medical or entrapment only cases. The average MAIS and ISS was also higher compared to medical or entrapment only cases.

Table 1. Crashes involving extrication by vehicle type

Extrication reason	Participants (n)	Average Age (years)	Average GCS on scene	Average vehicle age (years)	Average MAIS	Average ISS
Medical	6	53.2	14.8	8.5	1.3	4.2
Entrapment	23	50.6	14.9	12.2	1.9	7.9
Medical and entrapment	28	48.7	10.5	13.1	3.6	23.5
Total	57	49.9	12.8	12.3	2.7	15.1

There were 34 rural crashes (38 participants**)** and 15 metropolitan crashes (19 participants) requiring extrication as described in Table 2. In metropolitan areas, the most frequent crash types were hit fixed object and rear-end collisions, with average MAIS scores of 3.25 and 1.9 and ISS scores of 16.5 and 7.6 respectively. In rural areas**,** head-on and hit fixed object crashes were most common, and were associated with higher injury severity (MAIS head on: 3.1, hit fixed object: 3.2; ISS head on: 17.4, hit fixed object: 20.3).

Table 2. Crash type for metro and rural areas for 49 crashes resulting in 57 extrications

Crash type	Crashes (n)	Participants (n)	Average MAIS	Average ISS	Average age of vehicle (years)	Average time to hospital
Metro	**15**	**19**	**2.2**	**9.8**	**12.32**	**87.2**
Head on	1	1	3	17	20	-
Hit fixed object	4	4	3.25	16.5	16.25	104
Rear end	4	8	1.9	7.6	6.75	79.7
Right angle	2	2	3.5	18.5	16	99
Right turn	2	4	0.75	1.5	15.75	77
Rural	**34**	**38**	**2.95**	**17.8**	**12.24**	**157.2**
Head on	10	12	3.1	17.4	11.25	142.5
Hit fixed object	9	9	3.2	20.3	13.78	126.57
Loss of control	2	2	3	19.5	12.5	233.5
Other	1	1	5	38	6	197
Rear end	3	3	0.7	1.3	9.33	130
Right angle	3	3	2	9.3	7.33	208.5
Right turn	4	6	3.5	24.3	13.17	169.6
U-Turn in front	2	2	3	14.5	23	158.5
Total	**49**	**57**	**2.7**	**15.1**	**12.26**	**136.2**

Extrication time data was incomplete due to gaps in available ambulance documentation. Of the cases where extrication time was reported, six extrications lasted 20–45 minutes**,** while two prolonged cases lasted approximately 90 and 145 minutes. Because of inconsistent reporting, time to hospital arrival was used as a proxy for extrication time and compared with 184 crash cases without extrication**.** Table 3 describes the average time to hospital for extricated and non-extricated participants from in-depth crash investigation. A chi-square analysis was performed on the table results

but was not statistically significant**.** Even so, it is known that in real-world crashes even small delays may be clinically significant given the time-critical nature of major trauma care (Gonzalez et al., 2009).

Table 3. Average time to hospital for extricated and non-extricated participants

	Average time to hospital	
Location	**Extricated (n=40)**	**Not extricated (n=184)**
Metro	87.2 minutes	75.7 minutes
Rural	157.2 minutes	125.0 minutes

Benefits to road safety

Vehicle extrication is a critical component of post-crash care within road safety frameworks. Strengthening post-crash care within the Safe System can contribute to improved survival and recovery outcomes, while evidence from crashes requiring extrication can also inform road engineering, vehicle design improvements, and the adoption of technologies such as automated emergency call systems to support faster and more effective emergency response.

Implications for policy and/or practice

The findings of this study can provide a resource for road safety policy, trauma system planning, and emergency service practice. These findings can provide insights to improve emergency service response, inform resource allocation, and guide road and vehicle safety strategies aimed at reducing occupant entrapment and its consequences. The results highlight the potential role of emerging technologies and integrated emergency notification systems in improving post-crash outcomes.

Conclusions

The higher severity of rural crashes, particularly head-on collisions and fixed-object impacts, supports continued investment in road safety measures such as median barriers, roadside hazard reduction, speed management, and rural road upgrades. Given that even small delays can affect trauma outcomes, time-critical decision-making and early medical intervention during extrication remain essential. Many high-severity crashes requiring extrication may occur in locations where they are not immediately witnessed; therefore, automated emergency notification systems could help reduce delays between crash occurrence and emergency service activation, potentially improving response times and patient outcomes (Nishimoto et al., 2024). Finally, incomplete and inconsistent documentation of extrication times indicates a need for improved and standardised data capture within prehospital electronic medical records to support monitoring, research, and quality improvement.

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DRAFT

Geospatially-aware Artificial Intelligence for intersection crash rate prediction

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Abstract
Intersections present a challenging environment for road safety analysis due to their complexity and high dimensionality of contributing risk factors. Intersection environments commonly include intersecting roadways, pedestrian crossings, signalisation, safety treatments and varying lane configurations, often combined with public transport infrastructure. These factors create difficulties both for human transport planners and for analytical systems attempting to interpret large volumes of geospatial data. This study presents a geospatially-aware artificial intelligence (AI) model for predicting intersection crash rates. A geospatial processing pipeline was used to derive structured attributes describing intersection environments across the state of Victoria, Australia. These attributes were used to train a supervised regression model to estimate crash rate per intersection per year. The model achieved a Mean Absolute Error (MAE) of 0.058252 crashes per year, or an error of approximately one crash over 17 years per intersection. The results demonstrate promising potential for AI-assisted intersection risk analysis and prioritisation.

Background
Intersections are a critical component of road safety strategies. They frequently represent the interface between pedestrian and vehicular movement, and therefore concentrate multiple forms of conflict within a limited spatial area. In Australia, 27% of pedestrian fatalities occur at intersections (Australian Government, 2021). National statistics from the Bureau of Infrastructure and Transport Research Economics (BITRE) show that intersection crashes have increased since 2020, with a 6.9% increase recorded between 2022 and 2023 (Australian Government, 2025). The intersection environment is spatially heterogeneous and influenced by complex multivariable interactions. Factors such as geometry, lane configuration, traffic control devices, pedestrian activity and surrounding urban context interact in ways that make safety outcomes challenging to analyse and predict. Traditional approaches to crash analysis have often relied on reactive statistical methods based on historical crash frequencies or relatively simple regression models (Butt & Shafique, 2025). While these approaches provide useful insights, they may not adequately capture the nonlinear relationships and high-dimensional interactions that contribute to intersection safety outcomes (Silva et al., 2020).

Recent research has therefore explored the application of artificial intelligence (AI) and machine learning techniques to road safety analysis. AI-based approaches offer the potential to handle large datasets and uncover complex relationships within spatial data that would be difficult to identify using conventional statistical methods. A wide range of AI techniques have been proposed in the literature for road safety applications, including multilayer perceptrons, residual convolutional neural networks, hybrid deep learning architectures, graph transformers and data-fusion approaches (Ko et al., 2025). Despite these advances, several challenges remain in applying AI to intersection safety modelling. One major challenge lies in selecting appropriate variables that accurately represent the intersection environment. Another challenge involves the dimensionality of the geospatial data itself, as intersections exist within complex spatial networks. Practical constraints such as computational resources, infrastructure, and data availability can also influence the feasibility of implementing large-scale predictive models. Developing robust methods to encode intersection environments into machine-learning-compatible representations therefore remains a critical area of research.

Conference theme
This research supports the ARSC 2026 conference theme "From Evidence to Action: Shaping a Brighter Future" by presenting a novel approach to transforming historical crash data and environmental evidence into action for risk identification.

Method
Intersection crash risk was modelled as a supervised regression problem using a structured geospatial feature space derived from a geospatial processing pipeline applied across the road network of Victoria, Australia. The input dataset included observations from a wide variety of intersection types, ranging from small residential intersections to complex high-degree urban junctions. Rural road intersections were also included to ensure broad geographic representation. Each observation corresponded to a consolidated intersection object, represented as a vector of engineered attributes designed to capture geometric, operational, and contextual characteristics of the intersection environment. These attributes included measures related to intersection configuration, network connectivity, lane structure, and surrounding density, as well as statistical overlays representing contextual information such as speed environments.

The response variable used for training was crash rate per year. This measure was derived by normalising raw crash counts by the temporal coverage of the crash dataset. Using an annualised crash rate provides a continuous and non-negative target variable that allows comparisons between intersections with different exposure durations. A supervised regression model was trained using these intersection attributes to predict crash rate per year. Model performance was evaluated using several metrics, including Root Mean Square Error (RMSE) and Mean Absolute Error (MAE).

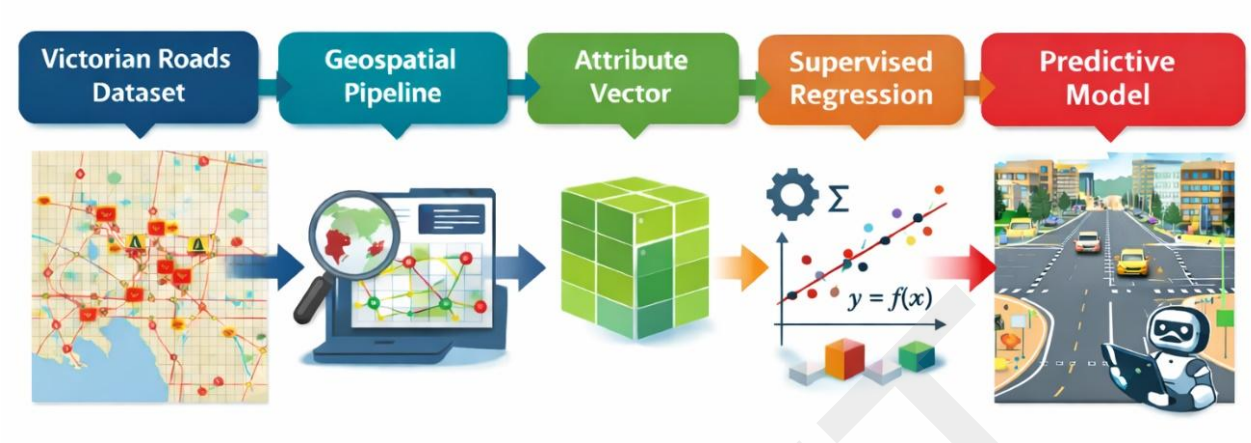

Figure 1. Architecture of the geospatially-aware AI.

Findings

The trained model produced a Mean Absolute Error (MAE) of 0.058252 crashes per year and Root Mean Square Error (RMSE) of 0.177626 crashes per year. The MAE of 0.058252 indicates that the mean absolute prediction error of the model is approximately 0.058 crashes per intersection per year. Expressed on a cumulative time basis, this corresponds to roughly one overestimated or underestimated crash over 17 years of exposure per intersection.

The RMSE value of 0.177626 is larger than the MAE. This difference indicates that the error distribution is not uniform across all intersections. Because RMSE penalises large prediction errors more strongly than MAE, the disparity between these metrics suggests the presence of a small subset of intersections with relatively large prediction errors. Qualitative inspection of intersections with the largest prediction errors showed that these locations were typically spatially large and geometrically complex intersections, often with irregular or unusual configurations. These sites commonly included features such as divided carriageways, staggered approaches, multiple traffic islands, or other complex layouts.

Taken together, the results indicate that the model successfully captured a meaningful portion of the safety-related variation present in the engineered intersection attributes. However, a relatively small subset of highly complex intersections proved more difficult for the model to predict accurately. This may reflect limitations in how the geospatial pipeline represents complex intersections, or the presence of additional contributing factors not captured in the available input data.

Benefits to road safety

The results of this work demonstrate the potential value of geospatially-aware AI in road safety analysis. The model developed in this study has shown promising predictive performance when compared with real-world crash data, particularly for the majority of intersections represented in the dataset.

One important benefit of this approach is its ability to analyse large numbers of intersections simultaneously. Traditional safety analysis often relies on manual inspection or reactive analysis of historical crash data, which can be time-consuming and limited in scale. By contrast, AI-based models can process extensive geospatial datasets and generate predictions across thousands of intersections. This capability allows transport agencies and local governments to identify patterns of risk across entire road networks rather than focusing solely on locations where crashes have already occurred.

Another benefit lies in the model's usefulness as a screening and prioritisation tool. Even when exact crash rates are difficult to predict, the model demonstrates an ability to distinguish between relatively higher-risk and lower-risk intersections. This capability enables planners to identify candidate locations for further investigation, engineering review, or safety improvements. In practice, such screening tools can help focus limited resources on locations where intervention is most likely to deliver safety benefits. Importantly, the technology can be applied at municipal or regional scales, where road networks may contain hundreds or thousands of intersections. In such environments, automated analytical tools can significantly improve efficiency and enable planners to incorporate safety analysis more consistently into planning and design processes.

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Implications for policy and/or practice

The development of geospatially-aware AI models for intersection safety analysis has several implications for transport policy and professional practice. The results demonstrate that machine learning techniques can provide meaningful predictive insights even when applied to complex spatial infrastructure systems. As data availability and computational capacity continue to improve, AI-based analysis may increasingly complement traditional safety assessment methods.

Whereas conventional crash analysis is inherently reactive, relying on historical crash records to identify high-risk locations, predictive models can instead highlight intersections that exhibit characteristics associated with elevated crash risk, even if crash histories are limited. This capability could allow planners to identify potential safety issues earlier and implement preventative design interventions.

The integration of AI-based analysis into planning workflows could improve the efficiency and consistency of safety assessments. By automating parts of the analytical process, agencies may be able to evaluate larger portions of the road network with fewer resources. This is particularly valuable at the municipal level, where planning teams often operate under significant resource constraints. Over time, as the reliability of such models improves, it is possible that transport planning guidelines and professional practice may evolve to incorporate AI-assisted analysis as a standard component of safety evaluation. Rather than replacing professional judgement, such tools would act as decision-support systems, augmenting the expertise of planners and engineers.

Conclusions

Artificial intelligence and machine learning techniques have emerged as promising tools for analysing and predicting road safety outcomes across complex transport networks. In this study, we developed a geospatial pipeline combined with a supervised regression model to predict intersection crash rates across the state of Victoria, Australia. Our model achieved a Mean Absolute Error of 0.058252 crashes per year, indicating that it has learned meaningful predictive relationships from the intersection dataset. When expressed cumulatively, this error corresponds approximately to one crash over 17 years of exposure per intersection. Prediction accuracy declined for highly complex intersections with irregular geometry or large spatial footprints. These findings suggest that future work should focus on improving the ability of the model to process these more complex inputs. The results demonstrate the potential of geospatially-aware AI systems to support road safety analysis and intersection risk assessment. With continued development, such technologies could play an important role in enabling more proactive and data-driven approaches to transport planning and road safety management.

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Empowering international students to be safer road users

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Presenter: Jack Carpenter

Abstract

International students face unique and complex challenges when navigating the Australian transport system, often arriving from environments with vastly different road rules, infrastructure, and cultural norms. This paper describes the development, delivery, and mixed-methods evaluation of the Fit to Drive Foundation's International Student Road Safety Program: a pilot intervention -facilitated with 70 international students at RMIT University in 2025. This initiative represents a critical shift from "one-size-fits-all" education to a culturally responsive, peer-led model grounded in near-peer facilitation and social learning principles. Through partnerships with RMIT University, Victoria Police, and Medibank Private, the program delivered interactive, contextualised workshops addressing Victorian road rules, the Graduated Licensing System (GLS), and gig economy risks. Pre- and post-session surveys and stakeholder focus groups were used to assess self-reported knowledge and confidence across five workshop sessions. Results indicated high levels of participant engagement and self-reported improvement across key road safety domains; however, findings should be interpreted with caution given the small pilot sample (n=70), absence of a control group, and reliance on self-report measures. The program addresses a gap in the National Road Safety Strategy by offering a scalable, replicable model for university-based road safety orientation.

Background

International students generally enter the Australian road system as pedestrians, cyclists, e-scooter riders, and novice drivers without a formal "on-ramp" to local road culture and unsurprisingly face unique vulnerabilities within the Australian road safety landscape (Centre for Automotive Safety Research, 2020; RMIT University, 2025). Research into Culturally and Linguistically Diverse (CALD) communities highlights that language barriers, unfamiliarity with local road rules (such as tram interactions) and differing cultural perceptions of risk contribute to a higher trauma risk (Yang et al., 2025). Compounding this, many international students who intend to drive are unfamiliar with Victoria's Graduated Licensing System (GLS), including its staged permit and licence requirements, leaving them ill-equipped to engage with the licensing system safely. The objective of this program, a strategic partnership between the Fit to Drive Foundation, RMIT University, and Medibank Private, was to bridge the "education gap" for 70 pilot participants through interactive, near-peer led workshops undertaken in 2025, specifically focusing on Victorian road rules, the GLS, licensing and safety within the gig economy.

International Students, Cultural/Geographic Disorientation, and the Gig Economy

Contemporary road safety research suggests a link between the "transfer of habits" from international students' home countries to the Australian road environment and a significantly higher risk of disorientation-related incidents; as well as overrepresentation in the "food delivery" sector, which is often characterized by high road exposure and potential systemic pressures:

- Right-Hand Side (RHS) Orientation: International students from countries with RHS driving conventions (i.e.: where vehicles drive on the opposite side of the road to Australia) are at increased risk of road trauma (Centre for Automotive Safety Research, 2020)
- Pedestrian Vulnerability: International students are often more vulnerable as pedestrians than as drivers. This is attributed to deeply ingrained cognitive habits, such as looking the "wrong way" when stepping onto a road (Yang et al., 2025).
- Intersection Complexity: A significant portion of trauma occurs at intersections where the "keep left" rule is momentarily forgotten under stress or fatigue (Watson et al., 2004).
- Economic Pressure: Students often prioritise delivery speed over road safety due to algorithmic management and the need to meet high living costs (Convery et al., 2020).
- Infrastructure Gaps: Many international student riders use e-bikes or scooters on infrastructure not designed for high-speed micro-mobility, leading to increased conflict with both pedestrians and heavy vehicles (International Transport Forum, 2020; University of Queensland, 2024).
- Under-reporting: Evidence suggests international students may under-report accidents due to fears regarding their visa status or lack of awareness of Workers' Compensation rights (Convery et al., 2020).

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Conference theme

The Fit to Drive Foundation's International Student Road Safety Program embodies the theme of 'Evidence to Action: Shaping a Brighter Future' by empowering a high-risk international student cohort to make safer choices on Victorian roads, in a manner that accounts for contemporary road safety research and identified policy and practice gaps. Through its culturally responsive, peer-led model, the pilot addressed a demonstrable education gap, with post-session surveys indicating that 98% of participants self-reported a better understanding of Victorian road rules (measured as a post-session response, not a pre/post matched score). While these findings are promising, they reflect self-reported confidence gains from a small pilot sample (n=70) without a control group and should be interpreted accordingly. This proactive, community-embedded approach offers a practical model for bridging the gap between research evidence on CALD road trauma risk and targeted educational action.

Method

The Fit to Drive Foundation adapted its evidence-based near-peer facilitation model to suit the international student experience, delivering a pilot program that embodied Fit to Drive's "shared responsibility" problem-solving approach and enabled road safety knowledge transfer without didactic lecturing. Key components included:

- Near-Peer-Led Facilitation: Young facilitators led workshops to reduce social distance and increase engagement.
- Multi-Agency Collaboration: Direct engagement with Victoria Police officers to build positive rapport with law enforcement and clarify legal expectations in a non-punitive setting.
- Contextualized Content: Specific modules addressed Victorian "hook turns," tram safety, e-scooter regulations, and the legalities of the Victorian Graduated Licensing System (GLS), including permit and licence stages.
- Practical Safety Skills: Coverage of pedestrian awareness, public transport safety, and emerging risks (e.g., lithium-ion battery safety for e-bikes).

The pilot 2-hour program was delivered at RMIT's Melbourne CBD campus. International students (n=70) attended one of the five programs (approximately 10-15 students per workshop) run in July and August 2025. Students had cultural backgrounds from over 20 countries with key representation from countries such as India, Vietnam, and China.
The COM-B Model of Behavior underpins the three main components of this pilot program. West and Michie (2021) describe behaviour as being motivated by an individual's capability (C), the opportunities available to engage in the behaviour (O), and the individual's motivation to complete the behaviour (M).

The first component of the Fit to Drive Foundation's pilot program "Generate" sought to build the confidence of students in using the roads. Within this first section, facilitators and students brainstormed their motivations (M) to use the roads with the goal of managing any negative feelings behind these motivations and generating confidence. Within the second component "Learn", students sought to learn key Victorian road rules and safe road-use strategies. The facilitators worked to build the capability (C) of students by contextualising information on the specific challenges these international students face while using the Victorian roads. This included Victorian "hook turns", tram safety, e-scooter regulations, the legalities of the Victorian Graduating Licensing System (GLS), and the Victorian licensing system. Furthermore, practical safety skills such as pedestrian awareness, public transport safety, and emerging risks (e.g., lithium-ion battery safety for e-bikes) were explored. The final component of the pilot program "Initiate" encouraged students to develop road safety strategies they would like implemented within their network and the wider community with the intention of influencing the physical and social opportunities (O) that are likely to influence their behaviour.

The Fit to Drive Foundation utilised a near-peer facilitation model. The use of young facilitators sought to reduce social distance and subsequently increase engagement. This pilot program embodied Fit to Drive's "shared responsibility", problem-solving approach that strove to enable road safety knowledge transfer without didactic lecturing. Direct engagement with Victoria Police officers aimed to build positive rapport with law enforcement and clarify legal expectations in a non-punitive setting. The pilot was sponsored by Medibank Private which provides health insurance to international students who are otherwise unable to claim on Australia's domestic Medicare health system.

Evaluation data was collected through pre-program and post-program mixed-method surveys, and post-program stakeholder focus groups. These evaluation methods investigated self-reported confidence and knowledge on road use and program feedback. No control group was employed, and all outcome measures were based on participant self-report, which represents a key limitation of these evaluation methods.

A mixed-methods evaluation approach was undertaken drawing on data collected throughout the five programs delivered via pre and post session surveys and focus groups. The pilot program achieved a 91% positive participant feedback rating and indicated high levels of self-reported road safety-related confidence (noting all figures below reflect post-session self-report from n=70 participants):

- Knowledge and Confidence Acquisition: Significant improvement in understanding local licensing requirements and the "Fatal Five" (speeding, drink and drug driving, distraction and inattention, not wearing seatbelts, and fatigue), including 98% of participants who gained a better understanding of Victorian road rules, 97% better able to identify local road signs and 95% feeling more confident to navigate Victorian roads.

- Regulatory & Safety Literacy: 97% learned the Victorian licensing process, 97% learned what to do in a crash and 100% learned how to mitigate road safety risks in the gig economy.
- Social Outcomes: 100% of students self-reported feeling more positively toward Victoria Police following the workshop, suggesting the multi-agency model may support improved community-law enforcement relationships, though this warrants further investigation.
- 100% Recommendation Rate: Participants unanimously indicated they would recommend the program to peers.

Of the 70 students who attended the program, a total of 59 students (16-26+ years of age; 57% female) completed the post-program survey. The post-program survey indicates high levels of road safety related confidence and knowledge on Victorian road rules. As measured by self-reported, dichotomous yes-no questions, 95% (n=56) of students felt more confident to use the roads in Victoria. 98% (n=58) of students stated they knew more about the Victorian road rules following the completion of the program. 97% (n=57) of students knew what Victorian road signs meant. 97% (n=57) knew how to get their Victorian license. 100% (n=59) of students knew how to avoid road safety risks in the gig economy. The post-program survey results also provided positive feedback on the program. As measured by a self-reported, dichotomous yes-no question, 100% (n=59) of students unanimously indicated they would recommend the program to fellow international students. As measured by a 10-point Likert scale, with 0 representing "Not good" and 10 representing "Great", the average score students rated the program was 9.4 (n=59). Results from post-program focus groups support the findings from the post-program survey. When asked about the new information gained following this program, students stated that they learned "what a hook turn [was]", "the unique road signs such as the kangaroo crossing", and "info and details about how to get a license".

Benefits to road safety

Through partnership with Medibank Private and RMIT, the pilot program reached a demonstrably high-risk demographic – young people under 25 years, who accounted for 26% of road trauma in Victoria between August 2020 to August 2025 (Transport Accident Commission, 2026); many of whom were new arrivals in Australia. The positive evaluation of the program has secured a further commitment from Medibank and RMIT to continue the pilot in 2026.

Implications for policy and/or practice

The findings from the Fit to Drive Foundation pilot program highlight several critical policy gaps that directly contribute to road trauma risks for international students. Currently, a significant "on-ramp" gap exists in the National Road Safety Strategy, as students often enter the Australian road system without formal orientation to local road culture. This lack of a structured transition period exacerbates risks related to geographic disorientation, such as "transfer of habits" where students from right-hand side driving countries may look the "wrong way" when crossing roads or forget the "keep left" rule at complex intersections. Victoria's GLS is also poorly understood by many international students, creating additional risk for those who wish to obtain a licence; embedding GLS literacy within university orientation programs represents a low-cost, high-reach policy opportunity. Furthermore, policy must address the systemic pressures of the gig economy, where 100% of participants supported the need for better risk mitigation strategies to counter economic pressures that prioritise delivery speed over road safety. By shifting from "one-size-fits-all" campaigns to culturally responsive, multi-stakeholder peer-led models, policy can more effectively address the specific vulnerabilities of this high-risk demographic. Through this, "[...] international students are given equal opportunities to learn and be part of the broader community" (Fit to Drive Foundation, 2025). The pilot offers a replicable implementation framework: near-peer facilitation, multi-agency delivery, culturally contextualised content, and university-embedded scheduling — components that can be adapted and scaled across institutions nationally.

Conclusions

The Fit to Drive International Student Road Safety Program demonstrates that effective road safety requires meeting people "where they are." By embedding education within the university orientation experience, we can move from reactive measures to proactive injury prevention. As the program expands in 2026, it serves as a blueprint for inclusive, culturally adaptive road safety programs across Australasia. The success of the RMIT-Medibank pilot demonstrates that tailored road safety education for international students is not only necessary but highly welcomed by the cohort. By moving from "evidence" (TAC data on CALD risk) to "action" (interactive workshops), the program offers a scalable model for universities nationwide. The results of this pilot should be interpreted in the context of its limitations, which include small sample size, absence of a control group, and reliance on self-reporting. Recommended next steps include expansion to regional campuses where road conditions and risks differ, and conducting a larger-scale study.

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DRAFT

Closing the School Zone Implementation Safety Gap

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Abstract
School zones remain high-risk environments for child pedestrians despite well-established countermeasures. In a rapidly urbanising secondary city in East Africa, baseline audits across three primary schools revealed the absence of zebra crossings and traffic calming, high motorcycle taxi volumes, weak pedestrian right-of-way compliance, unstructured drop-off systems, and no operational school-based road safety mechanisms. Between August 2024 and February 2025, an evidence-to-action framework was implemented, integrating engineering interventions, enforcement collaboration, teacher engagement, and community participation. Post-implementation monitoring demonstrated a 96.7% improvement in pupil road safety awareness, 90% observed compliance with signage among road users, reduced speeding behaviours, and zero schoolchild fatalities within intervention zones during the pilot. These findings show that translating risk assessment data into coordinated, low-cost, multi-sector interventions can rapidly strengthen school-zone safety. The model provides a transferable approach for jurisdictions seeking to close the implementation gap and accelerate progress toward 2030 road safety targets.

Introduction
Road traffic crashes claim approximately 1.19 million lives annually, with children and young people aged 5-29 disproportionately affected (WHO, 2023). Vulnerable road users, particularly school-aged pedestrians, face high exposure to crash risk. Evidence shows that speed management, pedestrian-priority infrastructure, and traffic calming significantly reduce crashes and injury severity (Elvik, 2019). However, a global challenge persists: the gap between policy intentions and on-ground implementation.

Baseline audits conducted in 2024 across three primary schools revealed:

- No zebra crossings or traffic calming
- High motorcycle taxi (boda-boda) volumes
- Weak pedestrian right-of-way compliance
- No structured school drop-off systems
- No trained crossing guards
- No teacher capacity for operational road safety education
- No school-based monitoring mechanisms

Despite inclusion of road safety in national curricula, implementation structures were absent at the school level.

Conference Theme
This project directly addresses the ARSC2026 theme: From Evidence to Action: Shaping a Brighter Future. By converting structured risk assessment evidence into measurable outcomes, the project demonstrates how engineering, enforcement, education, and community co-financing can be integrated under Safe System principles to reduce speed exposure and protect vulnerable road users. Rather than creating new theoretical knowledge, this work focuses on closing the implementation gap and offers a practical, replicable model for jurisdictions seeking to accelerate progress toward global road safety targets.

Project Description
An evidence-to-action implementation framework was applied between August 2024 and February 2025 across three primary schools in a rapidly urbanising secondary city in East Africa. The approach translated structured risk assessment findings into coordinated, multi-sector school-zone safety interventions aligned with Safe System principles.

Phase 1: Baseline Assessment
Comprehensive school-zone audits were conducted using structured observation tools. Data collection included:

- Traffic volume counts (with emphasis on motorcycle taxis/boda-bodas)
- Speed behaviour observations
- Pedestrian right-of-way compliance monitoring
- Infrastructure safety audits
- School transport and drop-off mapping
- Stakeholder consultations with school administrators, parents, local authorities, and traffic police

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Phase 2: Intervention Design
Audit findings informed a context-responsive intervention package integrating:

- Installation and repainting of zebra crossings
- Introduction of traffic calming measures
- Regulatory signage placement
- Structured drop-off and pick-up management systems
- Engagement of traffic police to strengthen enforcement visibility
- Teacher capacity-building sessions for operational road safety education
- Establishment of school-based monitoring committees

Phase 3: Implementation
Interventions were delivered collaboratively with local authorities, traffic police, school leadership, and community stakeholders. Community co-financing mechanisms were introduced to support crossing supervision and maintenance of safety infrastructure, enhancing local ownership and sustainability.

Phase 4: Monitoring and Evaluation
Post-implementation monitoring replicated baseline observational methods to ensure comparability. Indicators measured included:

- Pedestrian right-of-way compliance
- Road user adherence to signage
- Speed behaviour trends
- Pupil road safety awareness scores
- School-zone fatality records

Evidence-to-Action Framework (Aug 2024 - Feb 2025):

Phase 1 - Baseline Assessment:

- Traffic observations, infrastructure audits, behavioural monitoring, and stakeholder consultations.

Phase 2 - Intervention Design:

- Installation/repainting of zebra crossings
- Traffic calming measures
- Police collaboration
- Teacher engagement sessions
- Community dialogue mechanisms

Phase 3 - Implementation:

- Delivery of interventions with local authorities and traffic police
- Community co-financing to sustain crossing supervision

Phase 4 - Monitoring:

- Observational studies and school-based assessments to measure behavioural compliance and awareness

Results

Post-implementation monitoring showed:

- **96.7% improvement** in pupil road safety awareness
- **90% observed compliance** with road signage
- Reduced speeding in school zones
- **Zero recorded schoolchild fatalities** during the pilot
- Increased enforcement visibility and structured school transport management

Table 1. Observed improvements were consistent across all three intervention sites.

Indicator	Baseline	Post-Intervention
Functional zebra crossings	0	3
Traffic calming measures installed	0	3
Pedestrian right-of-way compliance (%)	35	90
Pupil road safety awareness (%)	42.3	96.7
School-zone child fatalities	1	0
Structured drop-off management	No	Yes
Enforcement presence during peak hours	Low	High

Benefits to road safety

This work demonstrates measurable improvements in school-zone safety through structured translation of evidence into action. Key benefits include:

- Increased pedestrian right-of-way compliance (35.00% to 90.00%)
- Significant improvement in pupil road safety awareness (42.30% to 96.70%)
- Installation of zebra crossings and traffic calming in previously untreated locations

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- Reduction in speeding behaviour during peak school hours
- Zero recorded schoolchild fatalities within intervention zones during the monitoring period

Figure 1. Gulu Primary school entrance before

Figure 2. Gulu Primary School after painting zebra crossing
Source: Developed by project team (2025).

Implications for policy and/or practice

The findings support the institutionalization of structured school-zone safety programs within local government and national road safety frameworks. Specifically, the results suggest:

- Mandatory periodic school-zone road safety audits
- Integrated engineering-enforcement-education delivery models
- Formalised crossing supervision systems supported by community co-financing
- Strengthened collaboration between schools and traffic enforcement agencies
- Operationalisation of road safety curriculum through trained teacher focal points

The measurable improvements observed indicate that coordinated, low-cost interventions can yield rapid safety gains and are transferable to similar urban contexts seeking to reduce child pedestrian trauma.

Conclusions

Translating evidence into coordinated, local-level action can rapidly improve safety outcomes in high-risk school environments. This project demonstrates that combining infrastructure upgrades, enforcement visibility, structured education, and community engagement significantly improves compliance behaviour and child safety protection. Closing the implementation gap between known countermeasures and on-ground delivery is critical to achieving global road safety targets. Future work should include longer-term crash outcome monitoring and replication across additional school zones to evaluate scalability and sustainability.

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Austroads crossing chart: addressing the driving forces around pedestrian safety

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Abstract

In 2026 Austroads published a research report identifying opportunities to improve pedestrian planning in the Austroads Guide to Traffic Management (AGTM). The report introduced a chart recommending different pedestrian crossings for roads according to vehicle operating speed and volume. In principle, the chart establishes the expectation that as roads become faster and busier, more protection is needed to support people crossing the road. In this way the chart resembles existing guidance in the AGTM for cycling facilities. This paper examines how the chart responds to industry and community concerns about safe crossings, particularly on roads with high movement functions. After considering three case study sites, we conclude the chart is a useful tool for crossing selection and guiding agencies to provide crossings that are safe and accessible for all users.

Background

Almost one third of road fatalities in urban areas in Australia are pedestrians (Department of Infrastructure, Transport and Regional Development, 2024). The risk of fatal injury to pedestrians is largely shaped by vehicle operating speeds and road environments that expose them to high-energy traffic. Most pedestrian crashes occur when people are trying to cross roads (CROW, 2009). As roads get faster and busier, the level of protection should increase. However, in Australia this is not always the case. Disappointingly, treatments such as refuge islands that do not slow vehicles continue to be endorsed for use in high-speed, complex environments where crash likelihood and severity are high.

In 2026 Austroads published a report identifying ways to improve pedestrian planning guidance. This report highlighted safety concerns around pedestrian crossings, particularly on higher-speed and multi-lane roads. To address these issues a new chart recommending different crossing treatments for different vehicle speeds and volumes was developed. In principle, the new chart establishes the expectation that as roads become faster and busier, a higher level of protection is needed. This chart works on similar principles to an existing chart for cyclists in Austroads Guide to Traffic Management, Part 5. Figure 1 shows the two charts side by side.

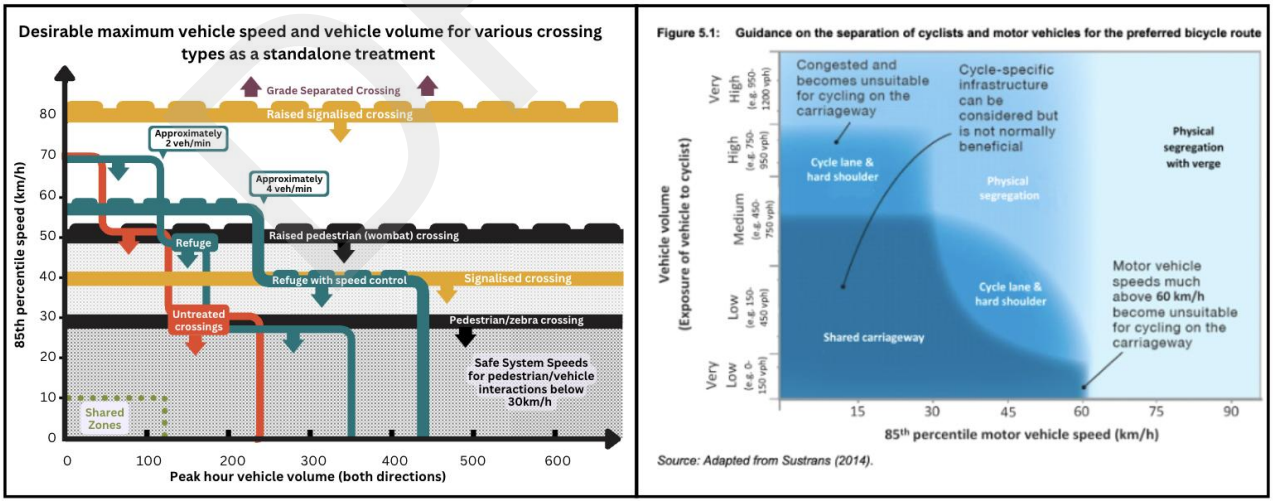

Figure 1. Left: Pedestrian crossing chart. Right: Cycling facility selection chart
Source: L. Austroads, 2026 p. 26. R. Austroads 2020. p. 55

The cyclist chart (Austroads, 2020) recommends different types of facilities depending on a road's vehicle volume and the 85th percentile operating speed. As speeds and volumes increase, more protection or separation is recommended. The chart references four types of facilities from shared carriageways to physical segregation with verge. Shared facilities are only recommended in environments with low speeds and volumes, physically separated facilities are recommended at sites with the highest speeds and volumes (See Figure 1).

The new pedestrian chart specifies eight at grade crossing facilities, plus grade separated facilities. Grade separated crossings provide the highest level of protection, and work across any volume and speed range. Raised signalised crossings also provide a high level of protection in speeds up to 80 km/h and for various volumes. In contrast, shared zones only work on roads with very low volumes and low speeds (10 km/h) (Austroads, 2026). Treatments that separate pedestrians in time (signals) or provide priority (zebras and wombats) are assumed to protect users as traffic volumes increase. Refuge and untreated crossings that rely on a pedestrian to pick a gap in traffic only work where volumes are low. This is so that someone who can't see, may be able to listen for a gap in traffic.

Conference theme

Evidence-based technical guidance is a mechanism for translating research into safer investments. This paper examines how the Austroads pedestrian crossing selection chart, which embeds Safe System principles and Universal Design principles into crossing selection aligns with community experiences of where safer crossings are needed. Findings show promising alignment between technical and social expectations for safer infrastructure that could support delivery.

Method

The Austroads crossing chart recommends different crossings depending on 85th percentile vehicle speed and the peak hour vehicle volume of the road, Figure 1. In this project we assessed the level of protection different crossings provided with respect to reducing likelihood and severity of crashes and providing for accessibility.

We also selected three case study crossing sites in Queensland to assess in relation to the chart. The sites had been identified by communities as places where safer crossings were needed. Case study sites had been identified in separate, localised studies that asked community members where they needed safer crossings using online surveys. Each site was the most important one in the town for improvements, according to community members. Sites were on state-controlled roads (where survey data was available). The case study sites were:

- An untreated crossing in the hinterland township of Yandina, on Queensland's Sunshine Coast.
- A refuge crossing in the coastal township of Pacific Paradise on Queensland's Sunshine Coast.
- A median/refuge crossing in Esk, a regional township 70 km north of Brisbane.

Traffic volume data for the study was referenced from the Department of Transport and Main Roads (2025). Eighty-fifth percentile operating speeds were sourced from CompassIOT (2025). For each site the study noted:

- Existing crossing type
- Recommended crossing types according to the Austroads chart
- Heat map showing community response to question 'where are safer crossings are needed?'

Findings

Table 1 summarises the level of protection provided by different crossing types. This was informed by Queensland Guide to Traffic Management (Transport and Main Roads, 2025). Crossings that satisfied likelihood, severity and access metrics to a high degree were ranked high or very high. Crossings that satisfied only two of these metrics ranked moderate. Treatments that did not actively reduce speed, or control vehicle movements to provide for pedestrians were given a low ranking.

Table 1. Levels of protection afforded by different crossing types

Treatment	Likelihood	Severity	Access	Level of protection provided
Grade separated crossing	✓✓✓	✓✓✓	✓✓✓	Very high
Pedestrian signals on raised platform	✓✓✓	✓✓	✓✓✓	High
Raised pedestrian (wombat)	✓✓✓	✓✓✓	✓✓✓	High
Pedestrian traffic signals	✓✓✓	–	✓✓	Moderate
Refuge crossing with speed control	✓✓	✓✓✓	✓	Moderate
Refuge crossing	✓	–	✓	Low
Zebra crossing (not raised)	–	–	✓✓	Low
At grade untreated crossing	–	–	–	Low
Shared zone	✓✓	✓✓	✓	Low

For each case study a visual storyboard was constructed that showed what the site looks like, how busy and fast it is, how people feel about the crossing and where does it fit in the Austroads Chart. Figure 2 shows the visual storyboard for Pacific Paradise. The storyboard shows that the volume of vehicles on this road far exceeds the threshold where the existing refuge crossing is likely to provide a suitable level of protection for pedestrians.

Table 2 summarises the findings from the three case study sites. For each site, the study found that the existing crossing provided a lower level of protection than the crossings recommended according to the Austroads pedestrian crossing

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chart. This supports the community perceptions that safer crossings are needed at these sites and shows alignment between new guidance and community perceptions.

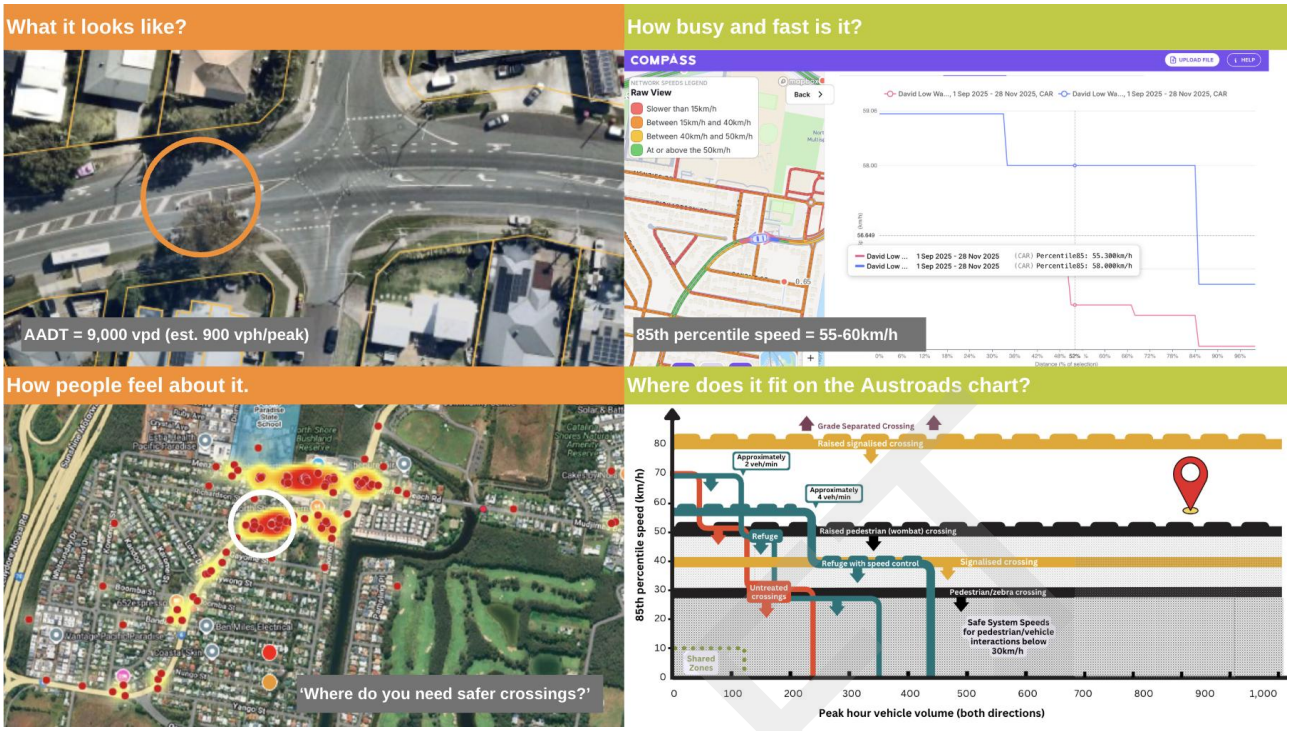

Figure 2. Storyboard for Pacific Paradise site Source: Nearmap, CompassIOT, Austroads.

Table 2. Summary of findings from the three case studies

Site	85th Percentile Speed	AADT	Existing crossing	Suitable crossings based on chart
Yandina,	55 km/h	6,000	Untreated	Grade separation Raised signalised intersection *Raised pedestrian/wombat if speed reduced
Pacific Paradise	60 km/h	18,000	Refuge	
Esk	48 km/h	6,000	Refuge/ Median	Raised signalised intersection Grade separation Raised pedestrian/wombat

Historical crossing guidance allows for practicable supportive treatments such as refuge crossings in complex, high speed environments. This may have resulted in over reliance on treatments that are technically straightforward but do not address safety and access issues for many users. Grounding guidance in physical road operating conditions provides a more reliable basis for agencies to plan appropriate crossing facilities and reduces the likelihood of inconsistent or inappropriate treatments being rolled out on the network.

Conclusions

Grounding crossing guidance in measurable operating conditions such as speed and traffic volume provides a consistent and defensible basis for selecting treatments that align with Safe System risk thresholds. This study also suggests that this type of guidance better aligns with community expectations for safer crossing facilities. A recommended next step would be to incorporate the chart into updates to the AGTM to provide improved clarity for agencies about the types of crossings that address safety and access needs of pedestrians.

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Mapping Of Active Transport Severance (MOATS) to deliver crossings

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Abstract

We can deliver safe and functional active transport networks to more people, more cheaply and quicky by focusing on mending existing transport networks and addressing specific points of severance. This paper presents Maps of Active Transport Severance (MOATS), a repeatable participatory mapping framework that converts community experience of safety and access into spatial datasets that directly support prioritisation of low-cost, high-leverage interventions. The project draws on a Queensland school-precinct case study using geospatial survey questions to map where safer crossings were needed. The study produced heatmaps to inform targeted site investigations, a ranked program of works and delivery of at least three infrastructure projects within three years. This demonstrates how MOATS can provide an efficient and repeatable method for the rapid roll out of low-cost projects to support safer trips to school.

Background

Australian road agencies invest approximately $30 billion each year maintaining, upgrading and expanding road networks, with approximately 20-40 percent spent on maintenance and renewal (Bureau of Infrastructure and Transport Research Economics, 2023). Programs incorporate a strong focus on sustaining assets, reflecting the enormous cost burden associated with road pavements and structures (BITRE, 2023). Maintaining active transport facilities in this context presents significant challenges. Active transport users experience roads differently to vehicle occupants. They are more vulnerable to crash forces and are continuously assessing threats. Their safety experience shapes how they feel, where they go and places they avoid.

An extensive body of research describes how humans respond to threats such as large, fast-moving objects. Responses include freezing, fleeing, and avoidance (Boyer & Bergstrom, 2011). The research suggests active transport users are capable of detecting traffic threats, and using clusters of reported concerns should therefore be meaningful indicators of risk (see Figure 1).

Figure 1: Human competence around detecting traffic threats.
Source: Canva images used to develop figure.

Current approaches to planning for active transport don't always capture these issues. Network planning simplifies where to invest by mapping strategic links between communities. Delivering these links can cost up to $5 million per kilometre (Victorian Government, 2024) and involve complex deliberations with stakeholders. Agencies complete tiny fractions of networks each year and projects are often delayed or cancelled after significant investment (Taylor, Steele, 2022). Network plans can also oversimplify where infrastructure is needed by focusing on arterial routes. Providing for neighbourhood routes including safer routes to school are just as important as trunk, or principal cycle routes (Goel et al., 2022).

Spatial community surveys have been used in studies in Queensland to understand where communities need safer infrastructure to get to schools and other places (Oswin, 2022). In these studies, community members responded to electronic surveys to identify where safer crossings were needed and the data was used to support planning and delivery of active transport infrastructure (IPWEAQ, 2025).

Conference theme

This paper demonstrates how gathering data from community members about where they feel threatened by traffic can provide a compelling case for investing in safer infrastructure. The case study demonstrates how this has been applied and the MOATS method defines a standardised process to apply in other locations.

Project Description

A case study from Queensland's Sunshine Coast was reviewed to consider how spatial mapping could be used to support delivery of active transport infrastructure around schools. The study was based in Sippy Downs, 100 km north of Brisbane. The precinct includes Sunshine Coast University, two P-12 schools, and commercial and residential land-use. The purpose of the study was to identify active transport projects that could be installed within 1–5 years and inform longer-term planning. The focus was on works that cost less than $500,000.

Engagement for the project was conducted through the school, via an online spatial survey shared with parents, carers and secondary students. The survey received 442 responses (341 secondary students; 101 parents/carers). Survey respondents placed up to 10 markers on maps to identify where better road crossings were needed for kids walking or riding to school. Comments were disabled to ensure answers remained relevant to the enquiry question. In total, community members place 802 markers, converging around approximately 16 sites (see Figure 2). Sites included mid-block crossings, roundabouts, uncontrolled and signalised intersections. Data was mapped as hotspots and was used to focus desktop and field investigations, rank and prioritise interventions.

The study was completed in 2022 and identified a list of 18 projects including shared paths, raised and flush pedestrian crossings and signalised crossings. Figure 2 shows a heat map produced in the study, the eighteen ranked projects, and aerial images of two crossings designed and constructed between 2022 and 2025 including a signalised crossing (Project 2) and a raised priority crossing (Projects 5).

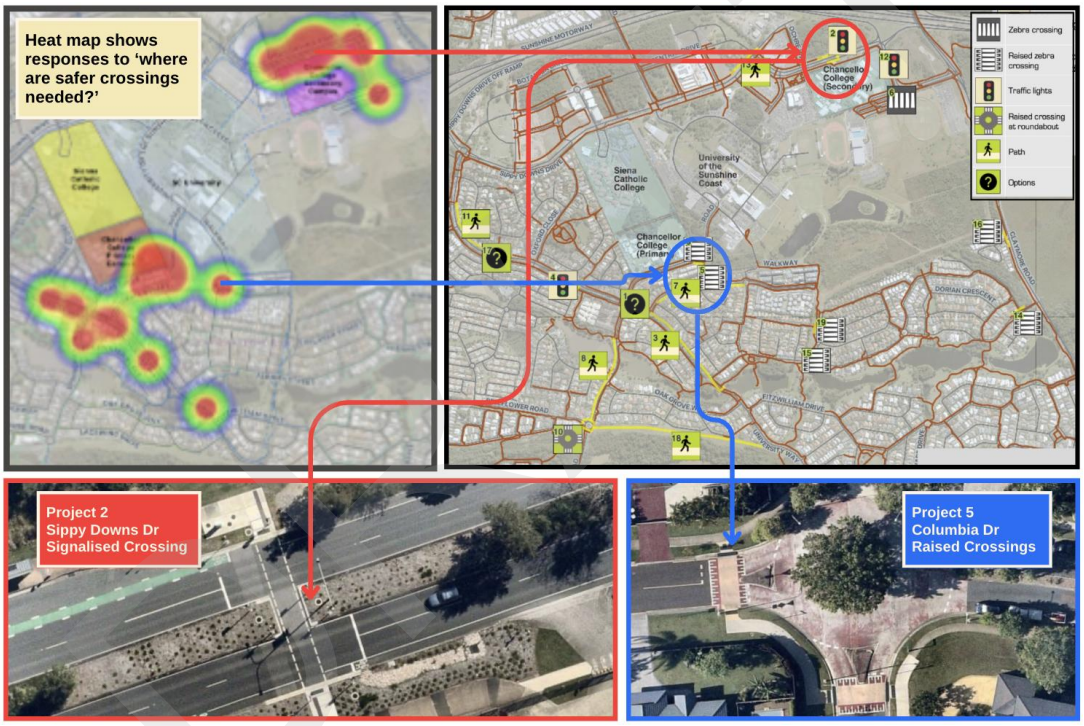

Figure 2: Precinct Plan and Aerial photos of two projects constructed since 2022.
Source: Nearmap and Sippy Downs Precinct Plan.

Results

Drawing on the case study and literature around severance and threat detection, a five-step framework was developed to describe how community insights around safety and access could be captured in a standardised process to directly support prioritisation of low-cost, high-leverage interventions. Figure 3 provides an overview of this framework. The proposed framework also references structured enquiry, questions, research insights and considerations and examples to guide applications in other contexts.

Figure 3: Human competence around detecting traffic threats.
Source: Canva images used to develop figure.

The output of this framework are Maps of Active Transport Severance (MOATS) that are developed by asking community members specific questions about where they need safer infrastructure to walk or ride. Each question must be able to be answered using a single or multiple points on a map. The platform should make it easy for people to place multiple markers on a map. Enquiry questions used in MOATS to date include:

- Where are safer crossings needed?
- Where are better paths needed?
- Are there any places where vehicle speeds feel too high?

Benefits to road safety

The MOATS method responds to a core problem identified in the transport literature how to identify optimal locations for active transport infrastructure improvements. Drawing on concepts from cognitive neuroscience, the method validates users' emotional and behavioral responses to dangerous traffic, as well as being a scientifically valid method for identifying risk. In this way, the method responds to challenges highlighted in transport and planning literature around community (transport) severance, transport innovation theory, and political science planning and maintaining active transport infrastructure.

Implications for policy and/or practice

Collating community safety insights from road users who want to walk or ride in their local area can help agencies garner evidence and a level of social support for road safety interventions, Figure 4. The evidence base provided by these insights can help steward the delivery of interventions through design and funding gateway processes.

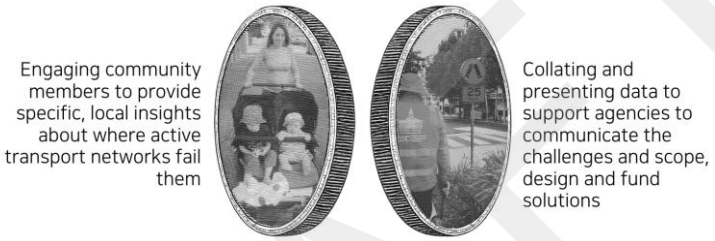

Figure 4: Two sides of MOATS model, representing community and supporting practice.

Conclusions

This paper considers existing methods for maintaining and planning active transport in Australia through a critical lens, that considers how these networks can be improved for the people who rely on them. We demonstrate ways that community insights can be gathered to identify where improvements are most needed, and to support projects to proceed from planning through to construction. The paper introduces the concept of MOATS. These maps are created by asking community members targeted questions in geospatial surveys to find out where they need safer infrastructure to walk or ride. Overall, MOATS can support authorities to deliver on what they typically state as their objectives: safer, more connected communities, driven by community voice. By merging the expertise of communications and transport professionals with the experiences of people who use local streets, MOATS provides a fast-track to better infrastructure and asset planning decisions.

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Behaviour change before infrastructure change: managing rapidly growing school traffic

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Abstract
Rapid growth in South-West Sydney has intensified traffic pressures around Edmondson Park Public School, which opened in 2023 and quickly neared capacity. The school sought Council assistance as congestion, unsafe driver behaviour and verbal abuse toward the crossing supervisor escalated. A staged intervention was implemented: (1) behaviour-first education and enforcement; (2) a trial removing staff management of the afternoon Kiss-and-Ride; and (3) operational changes including dedicating Buchan Avenue to buses, retaining morning Kiss-and-Ride, and converting afternoons to 15-minute park-and-walk. A key insight was that previous 2-minute No Parking rules encouraged unrealistic expectations of rapid turnover, prompting illegal queuing; longer-stay PM parking removed this incentive and reduced congestion. Outcomes included fewer conflict points, improved pedestrian predictability, reduced pressure on the supervised crossing, and significant decreases in complaints and infringements. This case demonstrates how staged, Safe System-aligned interventions improve safety in rapidly developing school environments.

Introduction
School environments present complex traffic management challenges, with short-duration peaks, high concentrations of vulnerable road users, and frequent interactions between children and vehicles during drop-off and pick-up periods. These conditions require careful design and management to minimise risks to pedestrians (Austroads, 2020).

Edmondson Park Public School is located within the South West Growth Area (SWGA), a priority corridor undergoing rapid residential expansion and major infrastructure development. When the school opened in 2023, the surrounding land was still developing, and the site initially had only two street frontages and no through-block loop, forcing nearly all vehicles to approach from the same direction. This constrained layout contributed to significant queuing during peak periods, amplified by the school's rapid growth in enrolments driven by accelerating residential development in South-West Sydney.

Shortly after the primary school commenced operation, a new high school was confirmed on the adjoining site. While this future development will introduce additional roads and a complete circulation loop, it will also place approximately 2,000 secondary students next to a primary school expected to reach 1,000 students. Recognising the scale of this emerging demand, Council and the school prioritised establishing a stable, safe and functional system at the primary school before the high school opens, allowing the community time to adapt and avoiding the need for further disruptive changes later.

Early observations identified unsafe driver behaviour, congestion, obstructed sight lines, and verbal abuse of the school crossing supervisor. These issues prompted the school to seek Council assistance. The rapidly increasing traffic demand, combined with vulnerable road users and a constrained road network, required a staged intervention that prioritised behavioural change before operational or infrastructure modifications, consistent with the Safe System approach to reducing harm to vulnerable users (TfNSW, 2022).

The success of the staged behavioural and operational program at the primary school has since informed planning with Schools Infrastructure NSW, ensuring that lessons on circulation, kerbside management and signage-related behavioural influence are incorporated into early design decisions for the adjoining secondary campus.

Conference theme
This project strongly reflects the ARSC theme "From Evidence to Action: Shaping a Brighter Future."
Observed safety risks and community-reported concerns were systematically translated into staged interventions, beginning with behaviour-based education and progressing through monitored trials to targeted operational changes. By grounding each step in evidence—direct observation, stakeholder input and behavioural analysis—the project demonstrates how local government can move from identifying emerging risks to implementing proportionate, effective measures that improve safety for vulnerable road users. The work highlights how practical, data-informed actions can reshape complex school-zone environments, strengthen compliance, and support long-term road-safety outcomes in rapidly developing communities.

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Project description

Setting and need
The SWGA's rapid development increased travel demand around the school. In NSW, 40 km/h school zones operate on notified school days—typically 8:00–9:30 and 14:30–16:00—to reduce risk for children, underscoring the need for orderly gate-front operations and compliance.

Staged Intervention

- Stage 1 – Education & Enforcement (Behaviour First) - End of Term 2 2025.
  Targeted communications to parents/carers on correct use of existing controls; reinforcement of stopping/parking rules; collaboration with enforcement partners; on-site observation to monitor compliance and traffic flow (consistent with NSW school-zone safety guidance).
- Stage 2 – Short Trial of Revised Afternoon Pick-up – End Term 2 2025
  Withdrawal of staff management of the afternoon Kiss-and-Ride; families asked to set clear meeting points—testing whether self-regulation would reduce dwell times and risky manoeuvres.
- Stage 3 – Permanent Operational Changes (Engineering/Operations) – Beginning Term 3 2025
  • Buchan Avenue: bus-only (AM/PM).
  • Faulkner Avenue: retain AM Kiss-and-Ride; convert PM to 15-minute park-and-walk.
  • Ancillary regulatory and signage changes to support visibility, turnover and compliance.

Design principles
Kerbside allocation, turnover policy and access control are established tools for reducing conflict and improving pedestrian priority on constrained local streets; these informed the operational changes.

Findings

Pre-intervention safety and operations:
Illegal stopping/parking near intersections and gates; obstructed sight lines; risky U-turns/three-point turns; the original Faulkner Avenue Kiss-and-Ride routinely generated an extensive queue that backed onto Buchan Avenue, blocking the supervised crossing and preventing the supervisor from safely allowing traffic to pass; this restriction, coupled with long delays, was a significant trigger for verbal abuse directed at the supervisor and heightened safety concerns for staff and students; the problem was most intense in the PM peak, when arrivals were highly concentrated (AM arrivals were more staggered).

Behavioural insight about time controls
Under No Parking / 2-minute Kiss-and-Ride controls, drivers assumed bays would vacate rapidly, creating a perceived justification to wait in the live lane for a "quick" turnover. In practice, overstays were common, turnover was slow, and the misaligned expectation produced long stationary queues.

Effect of the PM change to 15-minute parking
The 15-minute PM parking removed the incentive to queue in the live lane. When drivers arrived to find all bays occupied, they correctly inferred vehicles would not move soon, chose not to wait illegally, and instead dispersed to park elsewhere and walk - substantially reducing queuing, lane blockage and crossing pressure.

Post-change outcomes
Reduced vehicle circulation at gates and fewer conflict points along key pedestrian paths; improved conditions for the crossing supervisor and more predictable pedestrian movements; complaints to Council about congestion and driver behaviour have significantly reduced, and infringements issued have also declined, indicating improved compliance and community acceptance of the revised arrangements; residual PM congestion remains due to the short, intense demand window typical of school zones, but flow is more orderly and safer, consistent with the purpose of NSW school-zone controls.

Benefits to road safety

Safer pedestrian environment: Fewer gate-front conflicts, improved sight lines, and removal of the queue that previously blocked the supervised crossing on Buchan Avenue.
Operational clarity: Clear separation of bus movements (Buchan Avenue), AM Kiss-and-Ride and PM park-and-walk, improving predictability and compliance.
Community outcomes: Reductions in complaints and infringements signal sustained behaviour change and lower exposure to risky manoeuvres. The inclusion of Council's road safety messaging via the school's communication channels, on-site meetings to review and make improvements, all- showcasing the positive partnership between Council and the school community.
Policy alignment: Outcomes support NSW school-zone objectives to protect children through safer speeds, safer behaviour and safer environments.

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Implications for policy and/or practice

Behaviour before infrastructure - Begin with education and targeted enforcement; escalate to operational/regulatory change when behaviour does not improve sufficiently, aligning with Safe System harm-minimisation. (TfNSW, 2022)
Design for realistic behaviour - Time-limit policies shape expectations. Short limits (e.g., 2-minute No Parking) can unintentionally invite illegal queuing in high-demand PM periods; the transition to 15-minute parking better matched dwell patterns and reduced live-lane waiting.
Kerbside strategy as a safety tool - Integrate kerbside allocation, turnover settings and pedestrian-priority design—standard practice for reducing conflict in constrained school-frontage environments.
Plan early in growth areas - Schools in the SWGA operate in a rapidly developing urban context, where road networks evolve over time and demand grows quickly. Early traffic-management planning helps avoid repeated system redesigns as surrounding development progresses.
Collaboration is critical to successful outcomes - Effective school-zone safety relies on strong collaboration between the school, Council teams (traffic, rangers, community engagement), the TfNSW School Crossing Supervisor Unit, and local police. Aligning communication and expectations ensures consistent messaging and demonstrates to the community that all stakeholders are working as one team toward safer outcomes. The school is uniquely placed to communicate rapidly and directly with the entire community, ensuring that operational changes and safety messages reach families simultaneously and clearly.
Recognise the limitations of active-travel promotion in new growth-area schools - Although promoting walking, cycling and other active travel is a core safety and sustainability goal, new schools in developing areas are often not ideally placed to support these modes initially. Surrounding land may be undeveloped, footpaths and cycle links incomplete, and safe crossings limited—resulting in a continued heavy reliance on single-vehicle trips, especially for primary-aged children. As networks mature (more roads, continuous footpaths, safer crossings), schools can progressively shift toward active travel; until then, traffic-management solutions must account for high private-vehicle demand and still prioritise safe, predictable operations for vulnerable road users, rationale consistent with Safe System emphasis on protecting vulnerable users while networks evolve. (TfNSW, 2022)
Clear and accessible communication enhances community understanding and compliance - As part of the final stage of implementation, the school distributed a visual parking map to the entire school community, illustrating all available parking options, safe travel paths, and correct AM/PM use. The visual format aided families with language barriers, reduced confusion during the transition, and reinforced that Council, the school, the TfNSW School Crossing Supervisor Unit and NSW Police were working together as one team to improve safety and reduce congestion.

Conclusions

In a rapidly developing catchment, a behaviour-first, staged response at Edmondson Park Public School—progressing from education/enforcement to targeted operational changes—reduced gate-front conflicts, removed queues that blocked the supervised crossing, improved conditions for the crossing supervisor, and lowered complaints and infringements. The case offers a transferable framework for councils managing new or fast-growing school communities and aligns with NSW's Safe System trajectory and road-safety targets. (TfNSW, 2022)

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Motorcycle helmet oblique impact performance transformation – evidence from the CRASH program

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Abstract
Biomechanical and injury crash research demonstrates that angular acceleration of the head is a major contributing factor to brain injuries in motorcycle crash casualties. This presentation demonstrates how this research evidence has transformed the development of motorcycle helmet test methods, standards and technology (such as Angular Impact Management Systems (AIMS)), towards effective ways to manage and reduce the effects of impact forces acting on the head in crashes. Helmet impact test data from the CRASH program 2017 to 2025 have been analysed to assess changes in the impact performance of motorcycle helmets associated with AIMS and changes in the UNECE 22 regulation. AIMS equipped helmets reduced peak resultant head acceleration by 24% relative to non-AIMS helmets.

Background
An angular or oblique impact involves an impact force with a large component acting tangentially to the head in addition to a component acting radially towards the head's centre of mass. Research on head impacts in motorcycle crashes indicates that oblique impacts are prevalent.[1] Research on brain injury biomechanics and motorcycle crashes indicates that angular head acceleration arising from oblique impacts contributes to the type and severity of brain injury, e.g. subdural haemorrhages (SDH) and diffuse axonal injury (DAI).[2] As a result, there have been developments in helmet test methods, helmet standards/regulations and technologies in order to measure head impact dynamics in motorcycle crash-specific oblique impact tests and reduce specifically head angular acceleration.

The impact performance and protective capacity of motorcycle helmets in standards and regulations have, until recently, been assessed using the measurement of the linear acceleration of a helmeted headform in impact energy attenuation drop tests. In these drop tests, helmets are placed on a headform, the assembly is then raised to a specified height and released, and the helmeted headform impacts a rigid anvil (flat or V-shaped). In AS/NZS 1698 and UNECE 22.05, motorcycle helmet impact performance is assessed using drop tests.

The Consumer Rating and Assessment of Safety Helmets (CRASH) program commenced in 2009[3]. CRASH tests and rates motorcycle helmets each year against a range of safety protection and comfort criteria (https://www.motocap.com.au/testing-explained). It awards a star rating out of five for each criterion. The ratings assist consumers to relatively compare the safety performance and comfort for compliant motorcycle helmets at the point of sale, with detailed information; for example, the helmet's ability to withstand linear and angular (oblique) impact forces, noise levels inside the helmet, its ability to resist fogging, and more. CRASH aims to inform and guide riders towards choosing the safest helmets that suit their riding style.

Concurrently there have been some major changes in helmet regulations in Australia and internationally, which are reflected in CRASH. Examples of these include the changes Australia-wide permitting the supply of both AS/NZS 1698 and UNECE 22.05 (ECE 22.05) compliant helmets around 2017, and the implementation of UNECE 22.06 (ECE 22.06) in 2024. CRASH first tested ECE 22.05 only compliant helmets in 2016, and ECE 22.06 only compliant helmets in 2023.

ECE 22.06 superseded ECE 22.05 and added an oblique impact test requirement. Each helmet is evaluated in five tests (rear, front, lateral and angled lateral front and rear) onto a 45° angled anvil at a resultant impact speed of 8 m/s (29 km/h) in addition to the other impact energy attenuation drop tests. The UNECE 22.06 Acceptance Criterion is resultant peak rotational acceleration (PRA) < 10,400 rad/s^2. Well before UNECE 22.06's release, manufacturers had designed and incorporated AIMS, such as Multi-directional Impact Protection System (MIPS^{TM}) in motorcycle helmets. An oblique impact test method was introduced into CRASH in 2017, based on the method developed at UNSW within an Australian Research Council (ARC) funded project supported by Transport for NSW (TfNSW), Transport Accident Commission (TAC) and other partners[4 5]. The test involves dropping a Hybrid III head and neck assembly onto a moving roadway plate. Two tests are conducted per helmet in CRASH. The resultant impact speed in CRASH's oblique impact test is 11 m/s. Head and neck dynamics and the impact force are measured.

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The aims of this research are to demonstrate, through the CRASH program, trends in motorcycle helmet impact performance based on compliance with the UNECE 22.05 and UNECE 22.06 versions, and the incorporation of AIMS in the helmet.

Method

Data from 2017 to 2025 CRASH program compliant helmets testing were collated for analyses. The datasets comprised peak linear acceleration (PLA) measured in drop tests (low energy flat anvil, high energy flat anvil and high energy hazard anvil), and head kinematic data (PLA and PRA) measured in oblique impact tests. For all tests, the average PLA or PRA for each helmet and test condition were used, i.e. a helmet is tested at four sites and the average of the PLA for the four tests was calculated.

In total, for the period 2017 to 2025, 254 helmets were tested that complied with UNECE 22: 193 with UNECE 22.05 (no oblique impact) and 61 with UNECE 22.06 (oblique impact). An additional 16 helmets were compliant only with AS/NZS 1698 and were excluded from the study sample. Thirty-one (31) of the 254 UNECE 22 compliant helmets were equipped with AIMS and these were only full-face helmets. All open-face helmets (n=52) were excluded from the sample. The final sample included: UNECE 22.05 compliant full-face helmets – 127 without AIMS, 23 with AIMS; UNECE 22.06 – 44 without AIMS, 8 with AIMS. Full-face helmets are UNECE 22 category 'P' (protected). The presence of AIMS was established based on the supplier provided helmet labelling and product information, as well as direct inspection, including disassembling the helmets post-test.

To analyse the influence of adding the oblique impact test requirement in ECE 22.06, test results between ECE 22.05 vs ECE 22.06 compliant category 'P' helmets were compared using data from drop and oblique tests in CRASH.
To analyse the influence of AIMS on the helmets' impact performance, test results between AIMS and non-AIMS equipped category 'P' were compared using data from drop and oblique tests in CRASH. Independent samples t-tests were conducted to compare group means using IBM SPSS Statistics v29.

Results

The analyses of helmet impact performance based on compliance to UNECE 22.05 (n=150) or UNECE 22.06 (n=52) showed a significantly lower PLA in high energy (2.5 m drop height / flat anvil [$p<0.001$; $d=0.66$]) and low energy (0.8 m drop height /flat anvil [$p<0.001$; $d=0.53$]) impacts for UNECE 22.06 compliant helmets. The mean PLA in the high energy flat anvil impacts for UNECE 22.06 helmets was 158 g compared to 170 g for UNECE 22.05 helmets. There was no significant difference for head dynamics measurements in the oblique impact tests by UNECE version.

Table 1. UNECE 22.05 v 22.06 impact tests

	UNECE 22.05 (n=150)				**UNECE 22.06 (n=52)**			
	Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
High Energy (2.5 m) Flat Anvil – PLA (g)*	170	18	123	221	158	14	128	191
High Energy (2.5 m) Hazard Anvil – PLA (g)	149	20	97	247	149	15	117	193
Low Energy (0.8 m) Flat Anvil – PLA (g)*	90	10	70	111	85	9	65	109
Oblique Average PLA (g)	120	16	66	159	119	14	92	153
Oblique Average PRA (rad/s^2)	11413	2345	5622	18999	10960	2073	6899	15453

Descriptive statistics. SD = standard deviation. * indicates significant difference.

When helmets were compared on the presence of AIMS, AIMS equipped helmets showed a significantly lower PLA in high energy impacts (2.5 m drop height / flat anvil [$p=0.012$; $d=0.50$]) and both PLA [$p<0.001$; $d=0.79$] and PRA [$p<0.001$; $d=1.37$] in oblique impacts. The mean PRA for the oblique impacts was 8,923 rad/s^2 for AIMS equipped helmets compared to 11,727 rad/s^2 for non-AIMS helmets.

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Table 2. AIMS equipped helmet performance.

	non-AIMS (n=171)				AIMS (n=31)			
	Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
High Energy (2.5 m) Flat Anvil – PLA (g)*	168	18	130	221	159	18	123	205
High Energy (2.5 m) Hazard Anvil – PLA (g)	149	18	105	247	146	22	97	193
Low Energy (0.8 m) Flat Anvil – PLA (g)	89	10	65	111	86	9	68	107
Oblique Average PLA (g)*	122	15	81	159	110	17	66	153
Oblique Average PRA (rad/s^2)*	11727	2095	7787	18999	8923	1769	5622	14979

Descriptive statistics. SD = standard deviation. * indicates significant difference

Conclusion

The analyses showed that within the sample of helmets tested, compliance with UNECE 22.06 is associated with helmets that perform better on drop tests rather than in oblique impact tests. This may be a result of continued improvements in helmet technology, such as foam liner property selection and shell stiffness. There was no association between compliance with UNECE 22.06 and significantly better performance on the oblique impact tests in CRASH. This may be the result of manufacturers tailoring their helmets to meeting the requirements of the less severe oblique test in UNECE 22.06 (8 m/s) compared to CRASH (11 m/s), and differences in aspects of the test methods, e.g. rigid headform with no neck in UNECE 22.06 compared to a deformable neck and head in CRASH.

In contrast, the presence of AIMS in the helmet was associated with an improved performance in the CRASH oblique impact test. On average the mean PRA in AIMS equipped helmets was reduced by 24% compared to the helmets without AIMS, and the best and worst results (minimum and maximum) were reduced, respectively, by 28% and 21%. This shows that the overall range of test results improved with AIMS. Analyses of CRASH data suggests the presence of AIMS improves a helmet's performance in most impact tests, not just the oblique impact test. The data also show that design features of a helmet, regardless of presence of AIMS, can affect its performance in oblique impact tests.

The results suggest that newer helmets equipped with AIMS and complying with UNECE 22.06 have a greater likelihood of reducing the severity of brain injury than older helmets without AIMS and complying with UNECE 22.05. This is a positive change for motorcyclists through a combination of regulation and industry-led innovation, both informed by research. The CRASH program is well-placed to identify safety-critical helmet performance characteristics and communicate this information to motorcyclists.

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Effectiveness of pre-tensioned seatbelt use in child restraint crash safety

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Abstract
This study examined the effectiveness of seatbelt pre-tensioner use with different child restraint types in a crash, to assess child injury outcomes, addressing a critical evidence gap in how pre-tensioners interact with Australian Standards approved child restraints. Sled testing was performed using rear-facing, forward-facing and booster restraints, with sash pre-tensioned and non-pre-tensioned (baseline) seatbelts used. ATD (Anthropomorphic Test Device) sensor data was collected, and high-speed crash footage captured to assess child kinematics and excursion. In forward-facing and booster conditions, tests with pre-tensioned seatbelts were associated with lower head and chest acceleration and reduced head excursion, alongside higher neck loading that remained below IARVs. Pre-tensioner use with the rear-facing restraint resulted in an increase in head and chest acceleration, and neck force and tension, exceeding recommended IARVs. Australian Standards-approved child restraints may not be designed for use with pre-tensioners, with a need to better understand and implement design and performance criteria into restraint legislation to optimise injury outcomes.

Introduction
Pre-tensioned seatbelts are designed to keep a vehicle occupant secured to their seat, whilst removing slack from the webbing of the seatbelt to ensure optimal contact and restraint in the event of a crash (Valdano et al., 2023). Many modern vehicles are equipped with seatbelt pre-tensioners in the rear seat (Stockman et al., 2017). Current Australian child restraint standards (AS3629) do not test with a pre-tensioned seat belt, only a standard load-limited seat belt (Standards Australia, 2024). Limited research has examined how pre-tensioned seatbelts interact with child restraint systems and influence their crash performance. This study aimed to understand what effect the use of a sash pre-tensioned seatbelt can have on the injury and kinematic profile of a child, and what side effect this may have on the performance of different child restraint types, including excursion within the vehicle space, and restraint damage.

Conference theme
Child transport injury is the leading cause of death amongst Australian children aged 0-14 years old (Road Sense Australia., 2022). Child road fatalities in Australia increased by 35.7% between 2023 and 2024, with the number of fatalities in 2024 the same as in 2015, with overall road safety injury and death figures also on an upward trend (BITRE., 2025). Active vehicle safety technologies are also becoming standard across the board, including pre-tensioners in the rear seat of new vehicles, particularly with ANCAP testing setting a high standard. There is a need to better understand how to protect vulnerable road users. The interaction with pre-tensioned seatbelts in the rear seat of vehicles affects child safety, and the question remains around whether conventional Australian market child restraints are up to the task of being used with these systems, and whether they yield a benefit to child safety, and how this may affect legislation to ensure a high standard of safety.

Method
Thirteen frontal sled tests were conducted (peak acceleration=27g, ΔV=49km/h) using three Australian Standards-approved child restraints: a rear-facing convertible, a forward-facing convertible and a high-back booster. Each restraint was tested twice in baseline (non-pretensioned) and pretensioned sash-belt conditions using a standardised captain's chair. Restraints were replaced if damaged. One rear-facing restraint test was removed and repeated due to a sensor failure.

A Q6 ATD was used for all forward facing and booster restraint tests, and a Q1 ATD used for all rear facing tests. The dummies were instrumented with accelerometers in the head and chest, an upper neck load cell and chest deflection sensors. Data was filtered according to SAE J211 (SAE., 2014). Three high speed cameras recorded the impact at 1000fps in side, top and oblique views.

The kinematics of the ATD and restraint systems, including ATD containment and submarining, were evaluated qualitatively as observed on high-speed video. Outcome variables assessed included head and chest peak resultant accelerations, Head Impact Criterion (HIC15), peak chest deflection, and neck forces and moments. Peak forward head excursion for forward-facing and booster seats and upward head excursion for rear facing restraints, were calculated from high-speed video. The risk injury was assessed in accordance with the Injury Assessment Reference Values (IARVs), specifically AIS3+ 50% Logistic Regression analysis values (EEVC., 2008). The set-up is shown in Figure 1.

Figure 1. From left to right – Set-up of Rear Facing, Forward Facing and Booster Restraints

Results

Rear-Facing Restraints

The pre-tensioner counteracted the forward movement of the restraint, with consequent effects on the severity of the rebound and upward head excursion (1.5% larger). Plastic deformation was identified post-crash in the pretensioned seatbelt condition. As shown in Figure 2 below, with the use of a seat belt pre-tensioner, peak head acceleration increased by 21.3%, with HIC15 increasing by 24.4% and chest acceleration increasing by 6.4% compared to the non-pretensioned baseline. No chest deflection was reported due to a sensor failure. There was a substantial 55.3% and 73.6% increase respectively of neck force and Neck F_z tension. The neck moment decreased by 37.1% and neck M_y flexion increased by 4%.

Forward-Facing Restraints

The pre-tensioner counteracted the restraint motion, decreasing the forward head excursion of the child by 3.3% compared to baseline, reducing head contact risk with the vehicle seat in front. In addition, having the sash pre-tensioner only pulling from one side of the seat belt webbing led to sash guide damage, where the edge of the seat belt webbing cut through the guide, and increased the size of the slotted aperture, with abrasion also visible on the seatbelt webbing. This may also consequently lead to a shortened belt path, creating additional slack in the webbing. With the use of a seat belt pre-tensioner, peak head acceleration decreased by 8.2%, with HIC15 decreasing by 20.3% compared to no pre-tensioning. The chest acceleration resultant was roughly the same between both conditions. Chest deflection increased by 7.1% with the use of a pre-tensioner. There was an 8.3% reduction in neck resultant force compared to baseline, and Neck F_z tension decreased by 8.7%. The neck moment and neck M_y flexion increased by 7% and 7.1% respectively (Figure 3 below).

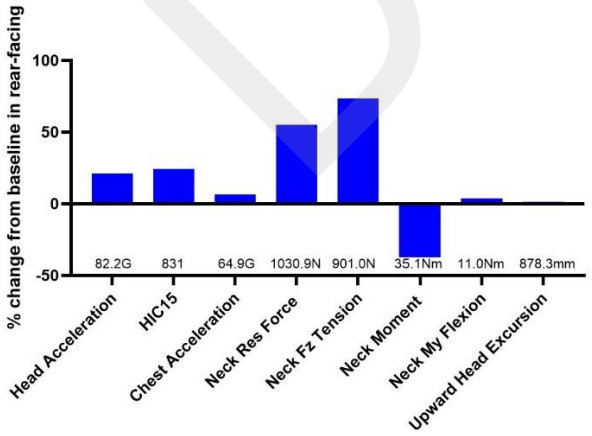

Figure 2. Rear-facing restraint with pre-tensioner metrics (% change blue bars) compared to baseline

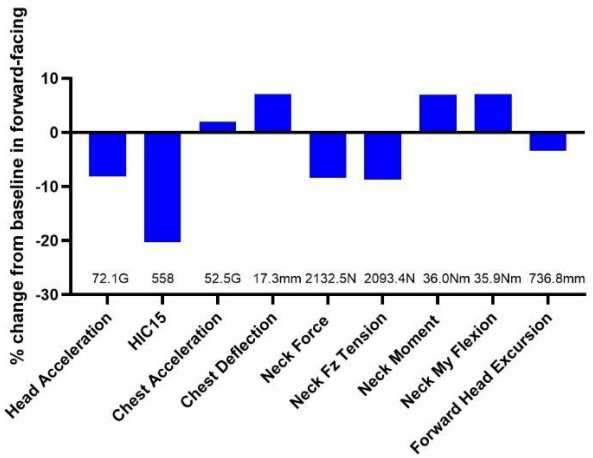

Figure 3. Forward-facing restraint with pre-tensioner metrics (% change blue bars) compared to baseline

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Booster Seat

Much like the forward-facing restraint, seat belt pre-tensioning also visually reduced the excursion of the restraint, with a 17.3% reduction in forward head excursion compared to baseline. With the use of a seat belt pre-tensioner, peak head acceleration decreased by 23.9%, with HIC15 decreasing by 46% compared to baseline. The chest acceleration resultant decreased by 27.6%, and chest deflection decreased by 5.6% with the use of a pre-tensioner. There was a 19% reduction in neck resultant force, with an 18.6% decrease in Neck F_z tension, however the neck moment and neck M_y flexion increased by 12.9% and 14.3% respectively (Figure 4).

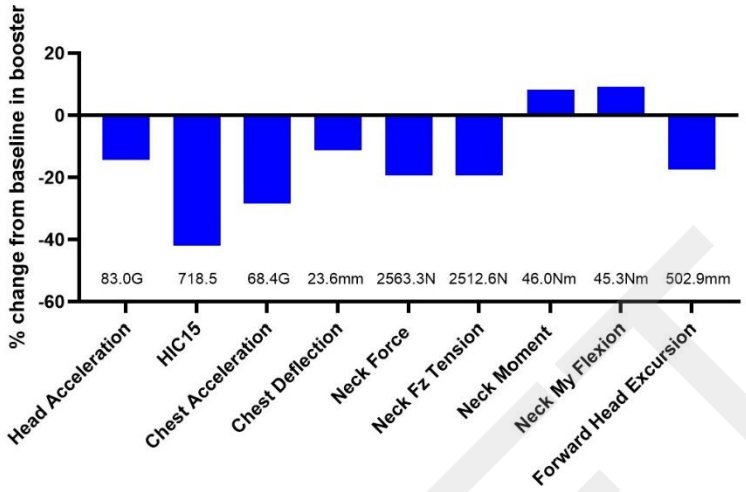

Figure 4. Booster seat with pre-tensioner metrics (% change blue bars) compared to baseline

Benefits to road safety

It is evident that current Australian market child restraint may not be designed or optimised to work with pre-tensioned seat belts, with concerns over durability and crash performance. For the rear-facing restraint tested, pre-tensioning appears to greatly increase the head and neck injury risk, exceeding IARVs in both baseline and pre-tensioned conditions. The use of pre-tensioning with forward-facing and booster seats appears to reduce most injury values, by reducing seat belt slack and restraining the motion of the child, with no values exceeding the maximum recommended IARVs in either condition. However, in counteracting the motion of the restraint, with reduced head excursion, this can cause a greater loading on the neck of the child.

Implications for policy and/or practice

There is a need to better understand the elements that can be used to inform design and performance criteria to positively impact the safety of child restraints, whether to recommend against using pre-tensioners with child restraints, or consider design and performance criteria to improve child safety with pre-tensioner use. This may be needed from a child restraint standard and legislation perspective, in collaboration with child restraint and automotive manufacturers.

Conclusions

It is evident that pre-tensioning adds complexity to the traditional function of child restraint design and performance during a crash, and this may need to be considered in child restraint standards. Further work is required to explore the pre-tensioner effect on other types and models of child restraints, and the influence of both sash and lap pre-tensioning for injury outcomes.

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DRAFT

Enhancing safety at passive railway crossings with peripheral flashing lights

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Abstract
This study developed and evaluated peripheral flashing light treatments designed to address common driver errors and enhance safety at passive Railway Level Crossings (RLXs). Two refined peripheral lighting treatments, PeriPoint (PO) and PeriPanel (PA), were evaluated using an immersive virtual reality (VR) driving simulation experiment (n = 50). The results show that peripheral flashing lights can promote earlier deceleration, reduce approach speeds, improve visual scanning, and facilitate earlier train detection relative to a standard passive (SP) crossing. Participants also reported favourable perceived benefits and preferences for the proposed treatments. Overall, the findings support an evidence-to-action pathway and suggest that peripheral flashing lights represent a promising low-cost enhanced-passive treatment for passive RLXs in regional areas.

Introduction
Passive railway level crossings (RLXs), particularly those in regional and rural areas, are high-risk locations, where collisions can have severe consequences. At passive RLXs, safe travel depends heavily on drivers' judgement as there are no train-activated warnings and no physical barriers. Road users' responses to level crossings are widely cited as the primary cause of RLX crashes. However, humans are fallible and process visual information inaccurately, as Safe System principles recognise. Based on drivers' perceptions approaching level crossings and recurring human responses, this study focuses on three behavioural safety domains: enhancing attention and expectancy, improving visual scanning and train detection, and promoting early deceleration and rule compliance (Rudin-Brown et al., 2014). However, existing interventions rarely improve all three domains together (Beanland et al., 2018; Larue et al., 2019; Silla et al., 2020) so multifaceted solutions are required.

Peripheral lighting is a promising direction, with the potential to support safety-critical human responses (Grippenkoven et al., 2015; Silla et al., 2020). Building on this concept, this study developed and evaluated two peripheral flashing light designs, PeriPoint (PO) and PeriPanel (PA), using a VR driving simulator experiment. The evaluation focused on outcomes including speed behaviour, visual scanning, train detection distance, and perceived effectiveness. PO and PA are economical, enhanced-passive designs, vehicle-activated, requiring no train detection or complex communication systems. They can be solar-powered and thus suitable for passive RLXs in regional and rural areas.

Conference theme
This study provides empirical evidence on the safety potential of the peripheral flashing light treatments, supporting the translation of research evidence into practical countermeasures through further research and future field trials.

Method
The experiment was conducted using a fixed-base driving simulator equipped with a Logitech G923 force feedback steering wheel and pedal system and an adjustable racing seat. The VR headset was an HTC VIVE Focus Vision with integrated eye tracking. The simulation environment, driving tasks, and data collection were implemented using Unity 3D.

Fifty participants were recruited through advertisements posted around the university campus and in the surrounding community (60% males). Participants' ages ranged from 19 to 59 years. Most participants held a full licence (80%). Around three-quarters of the sample (76%) reported driving more than 5,000 km per year. Over half (62%) reported encountering railway level crossings at least weekly. Prior experience with VR was also common (74% had used VR at least once). Participants received a $60 gift card as reimbursement for their time. The study was approved by the Human Ethics Committee (HEC24217).

Four scenarios were created in a setting representative of an Australian rural road (two-lane, two-way rural road). A default speed limit of 100 km/h was applied, with the limit reduced to 80 km/h on approaches to RLXs. Each scenario covered approximately 8.5 km of roadway and included four RLXs spaced at roughly 2 km intervals. Across scenarios, the four RLX treatments comprised one PO crossing and one PA crossing, together with standard passive (SP) and

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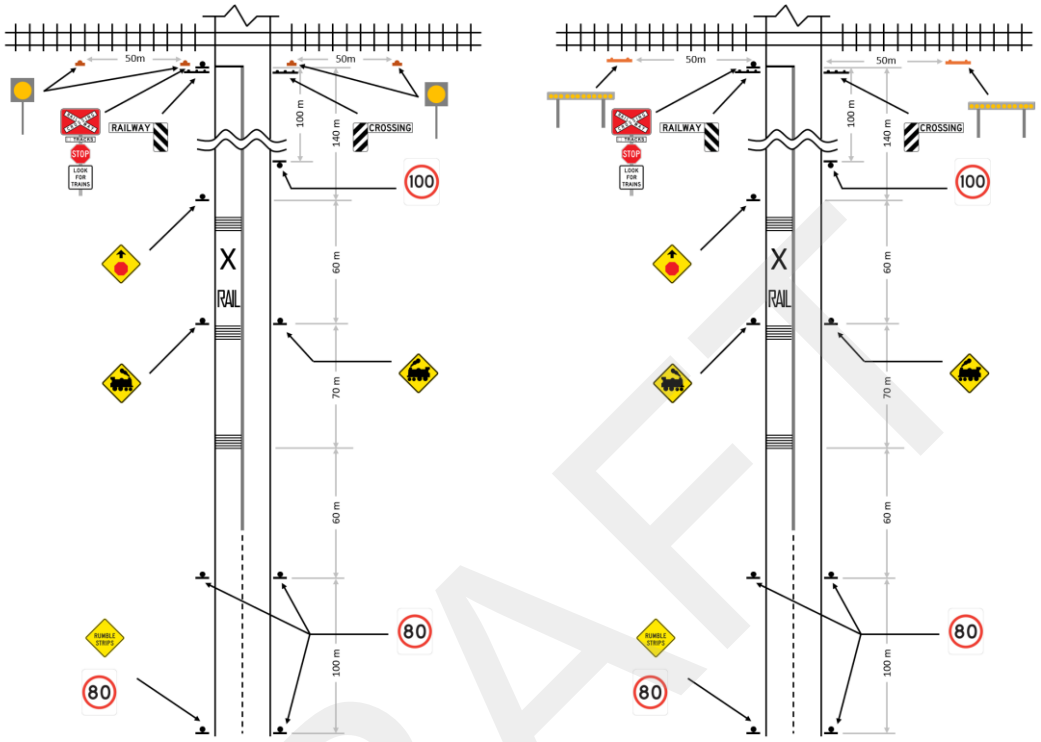
standard active (SA) crossings. Two scenarios were conducted under daytime conditions and two under nighttime conditions, with and without a train.

PO uses four point-source light units, whereas PA uses two linear light panels. Both are installed along the track and are activated by approaching vehicles. Figure 1 illustrates the layouts of PO and PA. When a vehicle reaches 200 m from the crossing, the lights are triggered and begin flashing in a wig-wag pattern. At 100 m, if vehicle speed remains above 50 km/h, indicating insufficient deceleration, the warning intensity increases: the light colour shifts from white to amber and the flash rate doubles.



a) PeriPoint (PO) b) PeriPanel (PA)

Figure 1 Layout of the peripheral flashing light designs

For the procedure, participants provided informed consent and completed a demographics questionnaire and the Virtual Reality Sickness Questionnaire (VRSQ). The VR headset was fitted, and the integrated eye tracking system was calibrated. Participants then completed a short training drive (approximately 5 minutes) to become familiar with the simulator. Participants completed four scenarios, with the VRSQ administered after each scenario. Finally, participants completed a post-drive questionnaire on simulator quality and perceived effectiveness of the new designs using a 7-point rating scale.

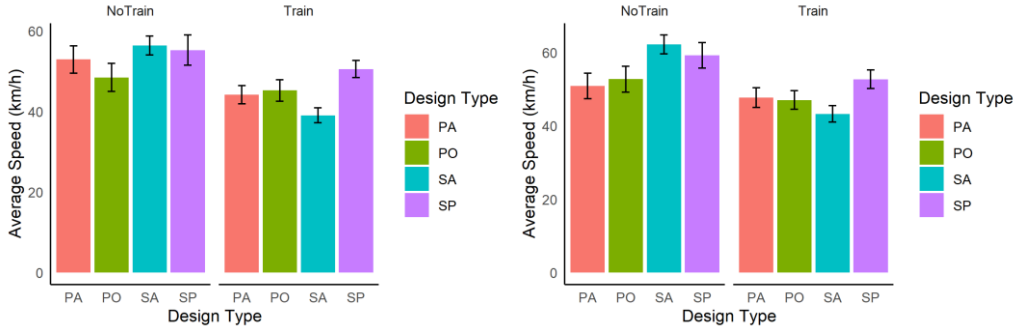
Results

Figure 2a shows the mean approach speeds under daytime conditions. In no-train scenarios, PO produced a significantly lower mean approach speed than SP. PA was slightly lower than SP, but this difference was not statistically significant. In the presence of a train, PO, PA, and SA were all associated with significantly lower mean approach speeds than SP. Figure 2b shows mean approach speeds under nighttime conditions. In no-train scenarios, mean approach speeds were substantially lower under both PO and PA compared with SP. With an approaching train, PO, PA, and SA were all effective at reducing overall approach speeds relative to SP. On average, PO reduced the mean approach speed by 6.35 km/h, while PA reduced it by 5.91 km/h. Spot speed analysis additionally showed noticeable speed reductions occurring as early as 150 m before the crossing from PO and PA when compared with SP.

Compared with SP, PO and PA increased visual scanning (measured as the percentage of time drivers looked left or right towards the railway track) by roughly 5 to 18 percentage points. Figure 3 summarises the results for the train detection distance, defined as the distance from the crossing at which the driver first detected the train. Under daytime conditions, compared with SP, the mean detection distance was slightly longer in the PA, PO and SA conditions, typically by about 4–8 m. At night, the differences were larger, approximately 13-18 m. Notably, PO resulted in the longest detection distance.

Participants reported favourable perceived benefits for the proposed designs. PO received consistently high ratings, typically above 6/7 across key items (e.g., scanning/detection 6.38/7, safer speeds 6.42/7, nighttime safety 6.74/7),

while PA was also viewed positively but at a lower level (around 5.6–5.7/7 on key items). In preference rankings, SA was most often ranked first by participants (62%), followed by PO (ranked first by 32% and second by 64%), and PA (ranked third by 60%). SP was ranked the least preferred by 82% of participants.



a) Daytime mean approach speeds b) Nighttime mean approach speeds

Figure 2 Daytime and nighttime mean approach speeds (0–200 m)

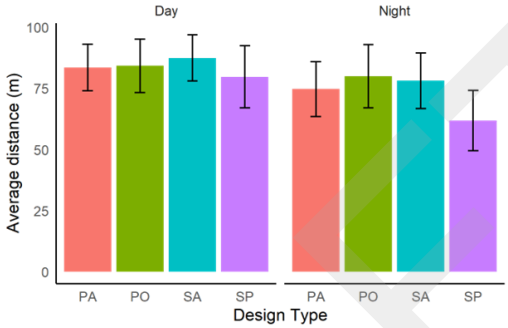


Figure 3 Train detection distance (daytime and nighttime)

Benefits to road safety

The peripheral flashing light treatments demonstrated clear safety potential by promoting safer behaviour, especially earlier deceleration, lower overall approach speeds, and enhanced train detection.

Implications for policy and/or practice

Peripheral flashing lights may be a suitable enhanced-passive countermeasure for passive RLXs in regional and rural areas where full active upgrades are often impractical.

Conclusions

This study links driver perceptions approaching level crossings to countermeasures that can improve responses. The results demonstrated the safety potential of two enhanced-passive peripheral flashing light treatments (PO and PA) through a VR driving simulation experiment with integrated eye tracking. Both PO and PA clearly outperformed the standard passive (SP) design across key safety measures. The results are more beneficial for improving driver behaviour than other comparable treatments. Future work should validate these findings through field trials and examine long-term effectiveness under varied road, environment and traffic contexts.

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Innovations in pole design for safer roads

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Abstract
Energy absorbing poles are designed to deform progressively and remain attached to the ground foundation after being struck to stop an impacting vehicle at a controlled deacceleration rate. However, there have been a number of challenges in implementing these poles. Until now, energy absorbing poles have not been approved for use on Queensland Department of Transport and Main Roads (TMR) roads due to concerns with wind loading performance and safe disconnection of the electrical power. A new Australian pole design now meets TMRs structural requirements. Previously, crash tests have not included testing of the electrical disconnection. To address this, an innovative electrical disconnect device that safely cuts power during a collision has been developed, mitigating the risk of electric shock. TMR conducted a crash evaluation at a National Association of Testing Authorities (NATA) accredited laboratory to validate the pole's compliance to Australian Standards. This presentation will detail the testing methodology and key findings from the test.

Background
Slip base poles are used for road lighting to provide a safer alternative to conventional fixed based poles for vehicle occupants involved in pole crashes. However, use of slip base poles is not recommended where there is significant pedestrian or cyclist traffic due to the high velocity of the unrestrained vehicle and pole after the crash.

Energy absorbing poles are another option. They are designed to deform progressively and remain attached to the ground foundation after being struck to stop an impacting vehicle at a controlled deacceleration rate. A road star rating such as the Australian Road Assessment Program AusRAP indicates how safe the road infrastructure is. The implementation of crumple poles where there is no other higher roadside risk object present would almost half the roadside severity risk factor used in the star rating calculation.

However, there have been a number of challenges in implementing these poles. Until now, energy absorbing poles have not been approved for use on TMR roads due to concerns with wind loading performance and safe disconnection of the electrical power. A new Australian pole design now meets TMRs structural requirements. The pole has previously been crash tested to 70 km/h. However, for TMR use, there was also a need to certify the product for up to 80 km/h. Previously, crash tests did not include testing of the electrical disconnection.

To address this, an innovative electrical disconnect device that safety cuts power during a collision has been developed, mitigating the risk of electric shock. TMR conducted a crash evaluation at a NATA-accredited laboratory to validate the pole's compliance to Australian Standards. This presentation will detail the testing methodology, and key findings from the test

Conference theme
In line with the conference's theme, *"From evidence to Action: Shaping a Brighter Future",* this presentation outlines the findings of pole crash testing and sets out steps that TMR is undertaking to incorporate the findings it its design standards and specifications, leading to the implementation of safer road environments.

Project description
The objective of this project was to develop and validate an electrical disconnection device that will safely disconnect the underground 230 volt from the base of energy absorbing poles, when struck by errant vehicles. In 2025, in collaboration with industry, TMR developed and tested a prototype device to ensure electrical safety compliance following a crash and enabling passenger survival from both the mechanical and electrical risks of such road crashes. A secondary objective was to extend the testing evidence from previously tested 70 kph vehicle speeds to 80 kph. The findings of the testing are being used to inform TMR's design standards and specifications.

Findings
In March 2025, a 10.5m energy absorbing pole with dual 3m outreaches was crash tested based on the requirements of AS/NZS 3845.22017 (Road Safety Barrier Systems and Devices, Part 2: Road Safety Devices), Test 2-40 with an impact speed of 81.4 kph.

The mast of the pole was deformed and flattened by the vehicle impact, arresting the vehicle within 4.2m of the initial impact point. The upper pole fell rearward, coming to rest on the roof of the vehicle. The pole remained attached to the footing. No vehicle deformation into the occupant compartment exceeded the Manual for Assessing Safety Hardware (MASH) limits. The pole met the evaluation criteria of AS.NZS 3845.2 for Structural Adequacy, Occupant Risk and Post-Impact Vehicular Response, noting that the pole access panel door and the luminaires detached from the pole during testing.

The time for the power circuit to disconnect following the start of the crash impact was accurately measured and recorded. The findings of the testing confirmed that the electrical disconnection device was effective in disconnecting the power circuit from the test pole at less than the 400ms maximum required disconnection time interval required for electrical safety.

Figure 1. Crash test of energy absorbing pole
Source: Transport for NSW Crashlab

Benefits to road safety

This project confirms the ability of an energy absorbing pole in conjunction with an innovative electrical disconnection device to safely arrest an errant vehicle traveling at 80 kph. This project demonstrates that energy absorbing poles with effective electrical disconnection devices can be an effective alternative to fixed based and slip poles, depending on the road environment characteristics.

Implications for policy and/or practice

TMR has not used energy absorbing lighting poles due to concerns with structural integrity and electrical safety. Following the findings of this project, TMR is revising its design standards and technical specifications to incorporate the use of energy absorbing lighting poles where appropriate to reduce road trauma from road crashes.

Conclusions

The outcome of this work demonstrates that energy absorbing lighting poles used in conjunction effective electrical disconnections devices can be used as an alternative to fixed base and slip based lighting poles. TMR is reviewing its design policy to allow for the use of energy absorbing lighting poles.

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Safe System centering women: shaping Cambodia's commuting safety future

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Abstract
Cambodia's garment and footwear sector employs over 918,000 workers, 75-80% women, who face life-threatening daily commutes on unsafe collective transport. Since 2017, interconnected commuting safety projects across 46 factories in eight provinces have applied the Safe System Approach through multi-level interventions centering women as agents of change. Nearly 500 Speak Up Champions, predominantly women, were trained to report unsafe conditions and lead advocacy. Between 2021 and 2023, combined results across 39 monitored factories demonstrated serious injuries declining by 74% (218 to 56) and deaths by 88% (8 to 1). Helmet wearing rose from 50.5% to 85.4% at brand-supported factories. Standing trucks declined from 66.6% to 19.0% at six original factories. All 46 program factories adopted Road Safety Policies, and a global brand embedded transportation safety in worldwide compliance standards. This evidence-based, gender-responsive model offers transferable lessons for protecting vulnerable commuting populations in low- and middle-income countries.

Introduction
Cambodia's garment and footwear sector employs over 918,000 workers across more than 1,500 factories, 75–80% of whom are women (Better Factories Cambodia, 2024). Despite their vital economic contribution, these workers face life-threatening conditions during their daily commutes. More than 200,000 workers rely on shared collective transport vehicles, over half of which are flatbed cargo trucks - vehicles not designed for passenger transport, often poorly maintained, unregistered, and routinely overloaded (NSSF, 2022). The human and economic toll is severe. In 2019, road traffic crashes cost Cambodia an estimated US$466.8 million, equivalent to 1.7% of annual GDP (UNDP & NRSC, 2021). For the garment and footwear sector specifically, data from the National Social Security Fund (NSSF) show that in 2024, commuting workers were involved in 4,416 road crashes, an average of more than eight per day, resulting in 81 deaths and over 5,039 injuries (NSSF, 2024). Women face disproportionate risk: as the vast majority of the GFT workforce, they are the primary victims of commuting crashes, yet have historically had minimal voice in transport safety decisions.

Since 2017, a series of interconnected commuting safety projects has been implemented across 46 factories in multiple provinces. Applying the Safe System Approach across all five pillars: safer road users, safer vehicles, safer roads and infrastructure, safer speeds, and post-crash response, these projects address the issue through multi-level interventions at the factory, worker, driver, and national policy levels. This extended abstract presents the combined evidence from 9 years of programming (2017–now), demonstrating how a comprehensive, multi-stakeholder model centering women workers as agents of change can achieve measurable reductions in road crash injuries and fatalities among a large vulnerable commuting population.

Conference theme
This work exemplifies "From Evidence to Action: Shaping a Brighter Future" through systematic translation of data into policy. Evidence from baseline surveys, GPS monitoring, helmet observations, and crash data drove action at three levels: factory-level Road Safety Policies adopted at all 46 program factories, national policy briefs contributing to Cambodia's Prime Minister's public commitment to transition to safer worker transport by 2027 (Khmer Times, 2023), and a major apparel corporation incorporating workers' transportation safety into its global facility compliance standards affecting 500+ factories worldwide. The gender-responsive approaches employed - peer-led Speak Up Champions, co-designed visual materials, and an economic case for industry stakeholders - offer a replicable model for engaging vulnerable populations in road safety globally.

Project description
Methodology and design: The comprehensive intervention model utilized the Safe System approach as its core organizing framework, operationalized through a multi-level design to address the complex nature of commuting risks at the factory, worker, driver, national, and industry levels. Recognizing that approximately 75-80% of the workforce consists of women, the project intentionally centered female workers as primary agents of change rather than passive beneficiaries. Through a gender-responsive design, women directly shaped policy briefs, complaint mechanisms, and

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peer education. To ensure interventions remained effective, the methodology relied on an evidence-based adaptive design anchored by baseline and endline Knowledge, Attitudes, and Practices surveys, objective GPS and video monitoring, transport mapping via GIS, and continuous crash data analysis.

Operationalizing the Safe System Pillars: To translate the strategic framework into measurable impact, interventions were systematically executed across all five interdependent pillars of the Safe System Approach. Safer road users: At the micro-level, Road Safety Working Groupswere established across 46 factories to drive localized Road Safety Policies. Over 410 "Speak Up Champions" - predominantly women - were trained to facilitate peer education, report unsafe conditions, and lead advocacy campaigns. These efforts were supported by targeted training for over 1,100 supervisors to sustain daily safety messaging. Safer vehicles: To mitigate the extreme risks posed by flatbed cargo trucks, a multi-stakeholder advocacy mechanism mobilized government bodies, trade unions, and major apparel brands to facilitate the transition to seated passenger vehicles. This culminated in a leading global brand adopting a standalone Workers' Transportation Safety section within its worldwide compliance standards. Safer roads and infrastructure: Evidence-based infrastructure assessments and drone mapping identified high-risk commuting zones, resulting in targeted localized improvements such as the installation of internal speed limit signs, division barriers, and improved traffic management coordination at factory gates. Safer speeds: Eco-Safe Driver Training was delivered to nearly 3,000 collective transport drivers, covering defensive driving and speed management. This was reinforced by GPS tracking technology to objectively monitor speed compliance and demonstrate the correlation between safer speeds and fuel savings. Post-crash response: To ensure comprehensive care and economic resilience for crash victims, the program pioneered factory-level Return-to-Work policies and established Disability Inclusion and Rehabilitation Working Groups. Furthermore, the intervention created referral pathways to guide injured workers in accessing national social security health benefits.

Results

Programs achieved measurable improvements tracked by a robust M&E framework. While interventions reached 46 program factories, the number with sufficient monitoring data varies by indicator. Consequently, results specify their scope, presented at two levels: the full monitored cohort and a subset of 13 factories with the longest four-year intervention period. Crucially, these main outcomes are cross-referenced with foundational evidence from an initial pilot phase to demonstrate longitudinal consistency. The findings are categorized into two logical tiers: operational outcomes across the five Safe System pillars, followed by the ultimate impacts on crash reduction and systemic governance.

Operational outcomes across Safe System Pillars

Safer road users: Workers' road safety knowledge increased significantly: helmet wearing knowledge rose from 91% to 98%, speeding awareness from 59% to 88%, and drink-driving awareness from 75% to 92%. Helmet-wearing rates measured through video observation increased from 50.5% to 85.4% at 13 factories with the longest intervention period (December 2020 to April 2024). Across all 41 monitored factories at aligned time points, helmet wearing rose from 60.7% to 76.6%. These objective measurements robustly align with early pilot phase findings, which recorded significant self-reported behavioral shifts, where average helmet wearing increased from 29.0% to 55.8% and a 21-percentage-point drop in speeding.

Safer vehicles: Vehicle fleet composition shifted dramatically. Standing trucks - the most dangerous transport mode - declined significantly at target factories. At six original brand-supported factories monitored over four years, standing trucks dropped from 66.6% to 19.0% of the fleet (November 2020 to June 2024). Overloading of surveyed vehicles dropped from 81.7% to 33.4% between 2021 and 2023. Crucially, these outcomes built upon foundational shifts observed during the early pilot phase, which not only reduced driver-reported overloading from 45% to 36%, but also demonstrated strong market demand, with 68% of target factory workers expressing willingness to pay a premium for safer transport. Ultimately, National commitment was secured: Cambodia's Prime Minister publicly pledged to facilitate transition to safer vehicles by 2027.

Safer roads and infrastructure: Transport mapping using GIS and drone technology identified high-risk routes and infrastructure gaps. Evidence-based advocacy with local authorities resulted in installation of speed limit signs, division barriers at factory gates, and traffic management coordination during peak commute hours. Infrastructure assessments at 13 factories documented conditions and informed provincial development plans.

Safer speeds and Eco-driving: Drivers completing eco-safe training showed significant improvement: those with excellent knowledge scores increased from 32% to 60%, and safe driving behavior from 27% to 47%. GPS monitoring confirmed measurable speed reductions post-training. Trained drivers self-reported fuel savings of 1-10 liters per week, demonstrating that safety and cost efficiency are complementary.

Post-crash response: The implementation of inclusive rehabilitation policies yielded highly positive economic recovery outcomes. The return-to-work rate for injured workers increased significantly from 83.3% in 2021 to 95.8% in 2023, successfully reintegrating 889 crash victims back into the workforce across the target factories.

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Ultimate Impacts and Systemic Change

Crash reduction: At 13 factories with the longest intervention, serious injuries dropped from 171 (2021) to 37 (2023), a 78% reduction, with deaths declining from 3 to 0. Combined data across 39 factories showed serious injuries fell from 218 to 56, a 74.3% reduction, and deaths from 8 to 1 - an 87.5% reduction over the same period.

Policy and Systemic change: All 46 target factories adopted formal Road Safety Policies, institutionalizing safety governance. A major multinational apparel brand embedded Workers' Transportation Safety in global Facility Compliance Standards, extending impact to 500+ factories worldwide. Three evidence-based Policy Briefs, each supported by 30+ stakeholders, were submitted to the government and informed national planning. Three policy briefs contributed to the Prime Minister's public commitment to transition to safer worker transport by 2027 (Khmer Times, 2023). Workers returning to work after crash injuries rose from 83.3% to 95.8% at brand-supported factories. A $500,000 UN Road Safety Fund investment (2024–2026) scaled proven interventions nationally.

Women's empowerment outcomes: Gender-responsive design yielded transformative results for women workers. Over 410 Speak Up Champions - 80% women - led awareness campaigns, advocacy, and complaint mechanisms across factories. The model generated 283 complaints in the pilot phase and 111 in the scaling phase, with a 67% resolution rate through engagement with drivers, supervisors, trade unions, and local authorities. –Critically, female workers' voices directly shaped Policy Briefs, factory Road Safety Policies, and advocacy strategies, shifting women from beneficiaries to architects of systemic change.

Benefits to road safety

This work demonstrates that a comprehensive Safe System approach, implemented through coordinated multi-project design, can significantly reduce road crash injuries and fatalities among a large vulnerable population. The model is replicable for other low and middle-income countries with large garment or manufacturing sectors, including Bangladesh, Vietnam, and Myanmar. Centering women workers as champions and decision-makers, rather than solely as beneficiaries, amplifies road safety outcomes and builds sustainable community ownership of safety interventions. The progression from pilot to national scaling, now supported by both UN funding and continued private sector investment, demonstrates a viable pathway from evidence to sustained action.

Implications for policy and/or practice

Evidence from this work supports four key implications. First, factory-level Road Safety Policies should be mandated nationally, building on the government endorsement already secured from the National Road Safety Committee. Second, the multi-stakeholder model engaging brands, unions, government, and civil society is replicable and have already expanded globally through one brand's compliance standards and the ILO's Vision Zero Fund. Third, road safety programs in garment-exporting countries should prioritize women's participation and leadership, given that women constitute most of the vulnerable workforce. Fourth, the co-authored Business Case demonstrates to fashion brands that worker transport safety compliance improves reputation, productivity, and reduces liability. The continued investment by both a UN road safety fund and a global brand in scaling phases confirms that the model generates sufficient evidence and stakeholder confidence to sustain beyond initial project cycles.

Conclusions

Since 2017, interconnected commuting safety projects have applied the Safe System Approach to create a comprehensive, evidence-based framework for improving workers' commuting safety in Cambodia. The combined impact across 46 factories demonstrates that sustained, multi-stakeholder programming centering women workers can achieve a 74% reduction in serious injuries, an 88% reduction in deaths, and significant improvements in helmet use, vehicle safety, and policy adoption. The sustainability and scalability of the model is evidenced by continued investment: a US$500,000 UN Road Safety Fund phase (2024–2026) is now expanding proven interventions with a target of 550 factories nationwide adopting Road Safety Policies, alongside a second phase of the brand-supported program (2025–2026) is expanding to 12 news factories with an emphasis on factory-led ownership and reduced dependence on external support. The Cambodian model offers transferable lessons for low- and middle-income countries seeking to integrate worker transport safety into broader road safety and decent work agendas.

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A network-wide approach to setting speed limits

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Abstract
This work presents the speed limit management framework, a network-wide, evidence-based approach for determining safe, appropriate, and consistent speed limits across local government road networks. Developed in response to the Victorian Department of Transport and Planning's 2025 Speed Zoning Policy, the approach integrates Safe System principles, Movement and Place classifications, spatial data analysis, and local context input to assess every road section within the Mornington Peninsula and assign context-appropriate speed limits. Using a structured five-step process, the framework identifies road categories, develops speed criteria, conducts risk assessments, and prioritises speed-limit changes, ensuring transparent and defensible speed limit change decisions. The approach replaces fragmented, corridor-based assessments with a network-wide perspective to support progress toward long-term trauma-reduction goals.

Background
Managing speed is a fundamental pillar of the Safe System approach, demonstrating its critical role in reducing crash likelihood and severity for all road users (ITF, 2022), in a cost-efficient manner. However, speed limit changes implemented in Local Government Areas (LGAs) are often reactive based on community requests and frequently focus on isolated corridors or individual road sections, which may result in inconsistent speed limits across similar road environments within the wider network. In August 2025, the Victorian Department of Transport and Planning (DTP) introduced a new Speed Zoning Policy aimed at establishing speed limits that are clear, intuitive, and consistent across the network (DTP, 2025), supported by both the Safe System approach and the Movement and Place framework. Recognising the need for a network-wide perspective in local government settings, we developed a comprehensive speed limit management framework that applied this new policy across the entire road network, ensuring more systematic and evidence-based speed limit decisions. Utilising the developed framework, a speed limit management plan was developed for Mornington Peninsula Shire, Victoria, and the results are included in the following sections.

Conference theme
This work addresses the ARSC 2026 theme by turning strong evidence (both reactive and proactive approaches) into actionable speed management decisions through the speed limit management framework. It responds directly to the need for consistent, Safe System-aligned speed limits by using data, risk assessment, and Movement and Place principles to guide transparent, network-wide changes. The framework supports impactful collaboration by integrating community engagement and enabling clearer communication with leaders, stakeholders, and road users. By addressing inconsistencies and highlighting where system-wide improvements are needed, the work contributes to the urgent effort required to avoid missing the 2030 serious injury and fatality targets.

Method
A comprehensive, fit-for-purpose methodology was developed to support the consistent and evidence-based selection of safe speed limits across the entire local road network. Figure 1 presents the speed limit management framework. The speed limit management framework analyses every individual road segment through a structured, data-driven process, supported by spatial datasets and local knowledge. These inputs include administrative boundaries, road characteristics and conditions, traffic data, land-use patterns, points of interest, Movement and Place, Infrastructure Risk Rating data, etc. Utilising data processing software, including QGIS (QGIS Development Team, 2026) and R (R Core Team, 2025), several models have been developed to combine these data into a comprehensive dataset.

The main process is divided into five steps (red boxes). First, all road sections are categorised based on the land-use, their Movement and Place functions, and proximity to the traffic generator locations. The categorisation reflects the 'Transport Network Efficiency' principle in the DTP Speed Zoning Policy (DTP, 2025), where speed limits are set in accordance with the Movement and Place functions of a road. Next, a set of criteria is developed, based on the defined criteria in the DTP Speed Zoning Policy (DTP, 2025), for every safe speed limit in each category. This means that, if a road section in one category meets the associated criteria, a certain speed limit should be applied to that road section. This decision-tree approach follows the 'Road Safety', 'Transport Network Efficiency', 'Community Wellbeing', and 'Road User Expectations' principles (DTP, 2025). The criteria include land use, road infrastructures and conditions, road user types and activities, traffic environment, risks, road safety treatments, etc. These data are derived from the input data by performing various spatial analyses and a network-wide risk assessment. The proposed network-wide risk

assessment is similar to the Safe System assessment, where exposure, likelihood, and severity risks associated with different road users (pedestrians, cyclists, and motorists) are assessed. In Step 3, using the results from the spatial data analysis, risk assessment, and community consultation, a processing model scans through each road segment, compares the existing conditions with the criteria and assign a safe speed limit. In addition, the input data undergoes several validation processes between Steps 1 and 3, including comparing with the DTP speed zone policy, to ensure the data captures the existing context correctly. Then, an area-wide speed change is considered, where a linked road network shows a need to reduce the current speed limit to a new speed limit. This helps to define the list of area-wide speed limit changes, ensuring the speed limit changes are clear and consistent across the network. Next, several indices are calculated for the prioritisation process in Step 4. These indices capture the risk levels, safety benefits of speed reduction using the Exponential Model (GRSF, 2023) and other constraints (e.g., cost, community preferences, feasibility). Finally, proposed actions are developed in Step 5, consisting of ranked projects with associated treatments to make sure the new speed limits are effective.

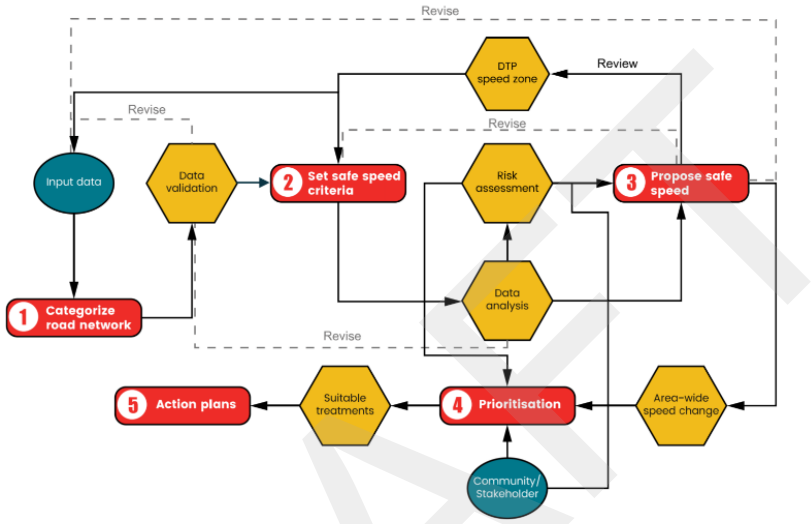

Figure 1. Speed limit management framework

Results

The speed limit management framework has been applied to the Mornington Peninsula road network. Figure 2 illustrates the outcome of categorising the Mornington Peninsula road network into 12 distinct road categories, developed in alignment with the DTP Speed Zoning Policy (DTP, 2025). Figure 3 presents a map visualising the risk categories assigned to road segments across the Mornington Peninsula. Each segment is colour-coded based on a Safe System–based assessment that evaluates exposure, likelihood, and severity of crashes. Risk scores range from 1 (lowest risk) to 5 (highest risk), providing a clear spatial representation of safety risk across the network.

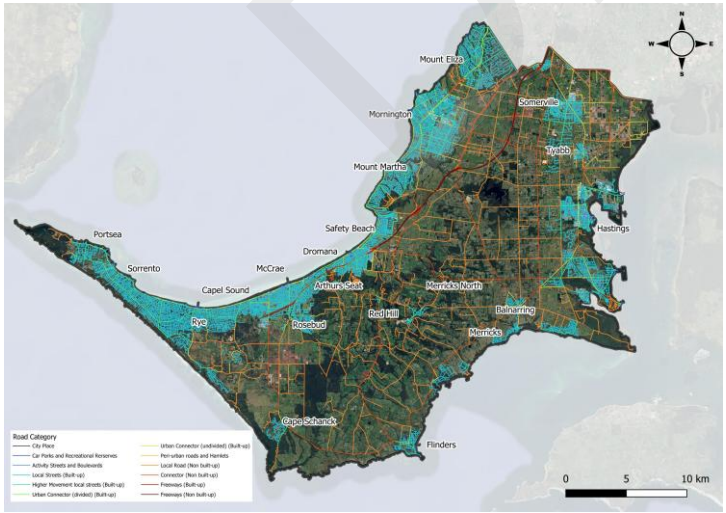

Figure 2. Road category in Mornington Peninsula

Figure 3. Risk categories on the Mornington Peninsula road network

Figure 4 illustrates the proposed safe speed limits generated through the speed limit management framework. Several red-circled areas indicate locations with potential for area-wide speed reductions. These locations typically correspond

to established residential precincts, town-centre road networks, and areas with higher exposure of pedestrians and cyclists. In addition to area-wide reductions, Figure 4 highlights specific recommended speed reductions on key rural roads and selected arterial corridors. An interactive map was developed to illustrate the results and assist in the validation process. A list of speed change locations was produced to provide a clear view for the Council and support the implementation planning accordingly.

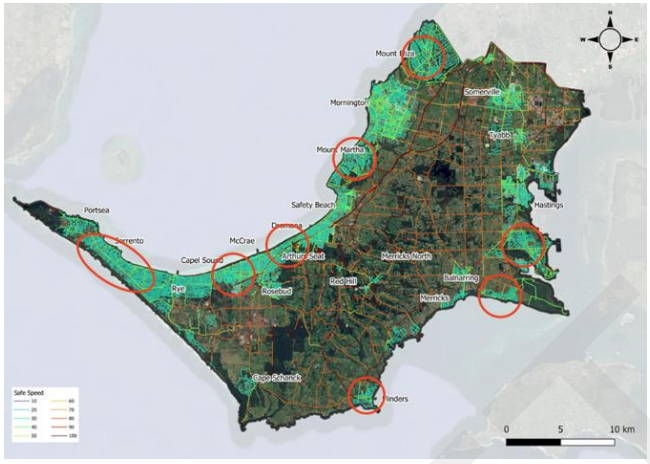

Figure 4. Proposed safe speed limit on the Mornington Peninsula road network

Benefits to road safety

This work strengthens road safety by successfully bringing the new DTP Speed Zoning Policy into practice, as well as supporting the Safe System approach and Movement and Place framework. By reducing inconsistencies and aligning speed limits with road function, risk, and local context, the speed limit management framework helps lower crash likelihood and severity while improving driver understanding and compliance, and facilitating wider scale implementation of safe and appropriate speed limit. Its innovative systematic, network-wide approach will provide Mornington Peninsula Shire with a proactive approach for speed limit setting, directly support progress toward 2030 fatal and serious injury reduction targets.

Implications for policy and/or practice

This work offers a practical pathway for translating speed-management policy into consistent, scalable action. By operationalising the DTP Speed Zoning Policy through a clear, data-driven framework, it enables local governments to move from isolated, corridor-based decisions to a network-wide, criteria-based approach that is easier to justify and communicate. The speed limit management framework also supports transparent decision-making and strengthens alignment with Safe System principles & Movement and Place framework. Moreover, the framework could be applied to other local government road networks, enabling significant reductions in road trauma by ensuring safe and appropriate speed limits - a core component of the Safe Speeds pillar. A similar framework could also be developed for local road networks in other Australian states.

Conclusions

The speed limit management framework provides a structured, evidence-based approach to achieving more consistent, context-appropriate speed limits across local government road networks. By integrating Safe System principles, spatial analysis, and the DTP Speed Zoning Policy, the method offers a practical pathway for improving network-wide speed management and reducing crash risk. This framework has the potential to equip local governments with the tools to make clearer, more transparent decisions that support safer travel environments and contribute meaningfully to meeting long-term road safety targets.

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Vietnam's evidence-based school zone model protects millions of children

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Abstract
Vietnam's rapid motorization combined with underdeveloped road infrastructure has made school zones high-risk areas for vulnerable road users, particularly students. To support improvements in traffic policy and prioritize student safety, AIP Foundation, with support from FIA Foundation and collaboration with the Ministry of Transportation and University of Transportation and Communications, developed the Safe School Zone Guide, outlining a model for safer school environments. To demonstrate its effectiveness, the *Slow Zones Safe Zones* program was, first, implemented in Pleiku City, beginning with two pilot schools and expanding to 31 schools with strong support from the Gia Lai provincial government. The Safe School Zones Guide (SSZG) was later released nationwide with the endorsement of the Ministry of Transportation as an official reference for local Departments of Transportation and based on the SSZG's successful results, a formal legal standard for school zones in Vietnam is being developed.

Introduction
More than 18.5 million children in Vietnam travel between home and school two to four times each day. However, traffic speeds in areas surrounding schools often exceed internationally recommended limits for school zones, creating serious safety risks. Until recently, gaps in the national policy framework meant that there was no clear definition or standard for what constitutes a safe school zone in Vietnam.

Although some schools and local authorities have introduced safety measures independently, these efforts have been implemented inconsistently and without guidance from a comprehensive national policy or engineering standard. As a result, essential safety features commonly applied in other countries are not consistently provided for Vietnam's school children, leaving millions vulnerable during their daily journeys to and from school.

Recognizing this critical issue created an opportunity for targeted intervention. In response, the Slow Zones Safe Zones program was launched in 2018, initially introducing the Safe School Zone model at two pilot schools. The program produced positive outcomes and received strong support from local authorities, creating momentum for broader expansion and leading to the development of the Safe School Zones Guide for wider national and international application.

Conference theme
This paper aligns with the theme "From Evidence to Action: Shaping a Brighter Future" by demonstrating how research and pilot interventions can drive practical infrastructure and policy change for child road safety. The Slow Zones Safe Zones program initiative generated strong empirical evidence showing that a multi-component approach—combining safer infrastructure, speed management, education, and policy engagement—can significantly improve school zone safety. Evaluations in Pleiku City found substantial improvements in road safety indicators, including school zones upgrading from low safety ratings to 4–5 stars, vehicle speeds reduced by up to 28.9%, and student crashes within school zones decreasing from 35.6% to 2.9% .

These results informed the development of the Safe School Zones Vietnam Guide, which was officially endorsed by the Ministry of Transport in 2023 as the country's first national reference on school zone safety. The evidence has since supported major policy actions, including Prime Minister's Directive 31 and national assessments of school zones.

Method
Infrastructure interventions included traffic calming measures, high-visibility pedestrian crossings, improved signage and road markings, and pedestrian safety enhancements around school entrances. These interventions were complemented by road safety education for students, teachers, and parents, along with community outreach aimed at improving driver awareness and behavior in school areas. Program effectiveness was evaluated using multiple data sources, including Star Rating for Schools assessments to measure infrastructure safety before and after interventions,

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vehicle speed monitoring during peak school travel times, observational surveys of road user behavior, and analysis of traffic crash data involving students within school zones.

Crash data from the students were also reviewed to examine changes in the proportion of student crashes occurring within school zones. The evaluation results demonstrated substantial improvements, including higher school zone safety ratings and reduced vehicle speeds, providing strong local evidence of the effectiveness of the model,with 71% of the schools getting the safest rating of 5 stars at the piloted program called Slow Zones Safe Zones.

Project description

Low Zones Safe Zones program launched in Pleiku City, 2018, with two pilot schools selected based on traffic risk, student exposure, and local government support, and later expanded to 31 schools. The afore-mentioned positive results influenced the Gia Lai provincial government's decision to issue a Legal Document, regulating speed around school zones at 30 km/h on city roads or 40km/h on national roads, and calling for Pleiku City to allocate funds from the city's budget to install road modifications in school zones. After five years, the Slow Zones Safe Zones program benefited 130,492 direct beneficiaries and 16,189,096 indirect beneficiaries.

The Safe School Zones Guide was developed through an evidence-based process that combined findings from the Slow Zones Safe Zones program's evidence with international best practices and national stakeholder consultation. Evaluation results from the Pleiku implementation—including improvements in school zone safety ratings, reductions in vehicle speeds, and changes in road user behavior—provided local empirical evidence for the effectiveness of the model. A review of global school zone safety frameworks and design standards was conducted to identify proven interventions related to safe speed management, infrastructure design for vulnerable road users, and school-based road safety programs. These findings were adapted to Vietnam's context through consultations with national and local government agencies, road safety experts, and education stakeholders. Based on this process, the guide was developed as a practical reference outlining definitions, design recommendations, implementation steps, and monitoring approaches for safer school zones.Moving forward, Vietnam Prime Minister's Directive 31, issued in December 2023, called for a comprehensive review and update of traffic management and infrastructure at school zones. In response, the Ministry of Transport issued Decision 64, instructing all 63 provinces in Vietnam to conduct thorough assessments and develop action plans for enhancing school zone safety within their respective jurisdictions. The Department for Roads of Vietnam has consistently encouraged provinces to adopt the SSZ Guide's recommendations to optimize traffic management in school zones and provide guidance for constructing new schools. In response to Directive 31 and Decision 64 issued between January 2024-January 2025, the Vietnamese government did invest USD 3.5 million to upgrade 3,300 schools across the country. This commitment aims to enhance safe mobility infrastructure, improve learning environments, and ensure that schools are equipped with safe infrastructure and resources to better support students and teachers nationwide.

Results

The Slow Zones Safe Zones and Safe School Zones Guide initiative focused on improving safety for children traveling to and from school by addressing high vehicle speeds, unsafe road infrastructure, and limited policy guidance for school zones in Vietnam. The program demonstrated that a comprehensive, evidence-based model could significantly improve road safety conditions around schools while generating practical lessons to inform national policy and transport planning.

The Safe School Zones Guide has directly contributed to:

1. Establishing a National Reference for School Zone Safety:

The evidence generated from the pilot and expansion phases informed the development of the Safe School Zones Guide, which outlines standardized definitions, infrastructure design solutions, speed management measures, and implementation processes for safer school environments. In 2023, the guide was officially endorsed by Vietnam's Ministry of Transport as the country's first national reference document for school zone safety.

2. Strengthening Evidence-Based Transport Policy:

By demonstrating measurable improvements in road safety indicators—such as reductions in vehicle speeds and higher infrastructure safety ratings—the program provided empirical evidence to support the integration of safer school zone design into national transport planning and road safety strategies.

3. Advancing Safer Infrastructure for Children:

The program highlighted the importance of designing roads that prioritize vulnerable road users, particularly children. The Safe School Zones model promotes safer road environments through traffic calming, improved pedestrian infrastructure, and clear speed management measures, ensuring that school areas are designed to reduce risk and protect students during their daily journeys.

Through these coordinated efforts, the initiative transformed local pilot interventions into nationally recognized guidance for safer school zones. By translating on-the-ground evidence into practical policy tools, the program has

helped lay the foundation for stronger transport regulations and infrastructure standards that prioritize child safety in Vietnam's rapidly evolving transportation system.

Benefits to road safety

The initiative also contributed to strengthening national road safety policy by demonstrating the effectiveness of a Safe System approach focused on vulnerable road users. The success of the Pleiku model helped build momentum for broader government action, including national assessments of school zones and increased investment in infrastructure upgrades for thousands of schools across the country.

Internationally, the program provides a valuable case study demonstrating how pilot interventions and data-driven evaluation can translate into scalable policy solutions. The model illustrates how evidence generated at the local level can inform national transport frameworks and contribute to global road safety efforts aimed at protecting children in rapidly motorizing countries.

Looking ahead, the experience of the Slow Zones Safe Zones initiative highlights the importance of integrating child-focused safety measures into transport planning and infrastructure development. By linking practical interventions with policy reform and national guidance, the program helps establish a sustainable pathway for improving road safety in Vietnam. These efforts are expected to contribute to a long-term shift toward safer road environments that prioritize vulnerable road users and support the development of a safer, more resilient transportation system for future generations.

Implications for policy and/or practice

The multi-stage evidence-based process played a pivotal role in sharing the government's opinions and actions in protecting students in school zones locally, nationally, and internationally. The following actions have shown how the Programs made its impact in shaping a brighter future:

- Vietnam Prime Minister's Directive 31, issued in December 2023, called for a comprehensive review and update of traffic management and infrastructure at school zones.
- The Ministry of Transport issued Decision 64, instructing all 63 provinces in Vietnam to conduct thorough assessments and develop action plans for enhancing school zone safety within their respective jurisdictions.
- In response to Directive 31 and Decision 64 issued between January 2024-January 2025, the Vietnamese government invested USD 3.5 million to upgrade 3,300 schools across the country.
- The Safe School Zones Guide has achieved successful results, and it is being referenced for a formal legal standard for school zones in Vietnam.

Conclusions

The Safe School Zones Guide initiative demonstrates how evidence-based interventions can drive meaningful improvements in road safety and influence national policy development. Beginning as a pilot program in Pleiku City, the initiative successfully tested a comprehensive model for improving safety around schools through infrastructure improvements, speed management, education, and stakeholder collaboration.These results provided strong empirical evidence demonstrating the effectiveness of a comprehensive school zone safety model. The guide provides practical guidance for infrastructure design, speed management, and implementation strategies that can be applied by transport authorities and local governments across the country.

The national endorsement of the guide by the Ministry of Transport represents an important milestone in strengthening Vietnam's road safety framework and ensuring that the needs of children are better integrated into transport planning and infrastructure development.

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Significance of regular, ongoing post-implementation monitoring of road infrastructure

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Abstract
This work examines the significance of regular, ongoing post-implementation monitoring of road safety infrastructure to ensure safety outcomes are being achieved. The study focuses on two treatments applied across the existing road network: median barriers and intersection speed zones. Selected sites in New Zealand were analysed using pre- and post-implementation crash data to assess changes in Death and Serious Injury per year (DSI/year). Overall, the results show that these interventions play an important role in reducing DSI, demonstrating clear safety benefits when appropriately implemented. The findings reinforce that continuous monitoring is essential for confirming treatment effectiveness, understanding unexpected outcomes, and ensuring that the findings translate into future policy and practices.

Introduction
Road trauma remains a persistent public health issue in New Zealand, with 272 road deaths recorded in 2025 (Ministry of Transport, 2026). Unsafe speeds and road layout factors contribute significantly to fatal and serious-injury crashes, with Auckland Transport evidence shows more than 70% of fatal crashes in Auckland involve speeding (Auckland Transport, n.d.) and speed limit changes have demonstrably reduced deaths and serious injuries. As a result, treatments such as median barriers and intersection speed zones (ISZs) have been increasingly implemented across the network to help reduce safety risks. Recent evaluation work, in conjunction with NZ Transport Agency (NZTA), provided a deep-dive analysis on two key treatments using pre- and post-implementation crash data, providing evidence on their performance and reinforcing the need for continuous monitoring to support better-informed safety decisions.

Conference theme
This work directly supports the conference theme *From Evidence to Action: Shaping a Brighter Future* by demonstrating how real-world safety performance data can inform practical decision-making. Through systematic post-implementation monitoring, the analysis provides clear evidence of where road infrastructure is performing well and where further action is required. By turning crash data into actionable insights, the study enables road controlling authorities refine treatments, improve safety outcomes, and drive continuous improvement across the network.

Method
To assess the effectiveness of median barriers and intersection speed zones (ISZs), this study used pre- and post-implementation crash data sourced from the Crash Analysis System (CAS) dataset maintained by NZTA, which stores all police-reported injury crashes nationwide. DSI numbers were extracted for each selected site, enabling comparative trend analysis.

- **Median barrier sites**: For the 10 selected State Highway corridor sites, death and serious injury crashes occurring on mid-block (link and corridor) segments were collected for a 10-year period before and up to 10 years after the median barrier installation.
- **Intersection Speed Zones (ISZs)**: For rural ISZ installations, CAS data within a 100m radius from the centre of the intersections was extracted for five-year and ten-year periods before and after installation. 21 sites were assessed. Crashes that are irrelevant to the intersection like crashes involved drunk drivers are excluded in this assessment. DSI per year is then calculated for each site before and after the installation of ISZ.

Results
Median barrier CAS data findings
Across the 10 sites assessed, all demonstrated a reduction in DSI per year following the installation of median barriers. On average, these sites experienced a 70% reduction in DSI, despite two of the median barriers being relatively recent installations (around 2023).

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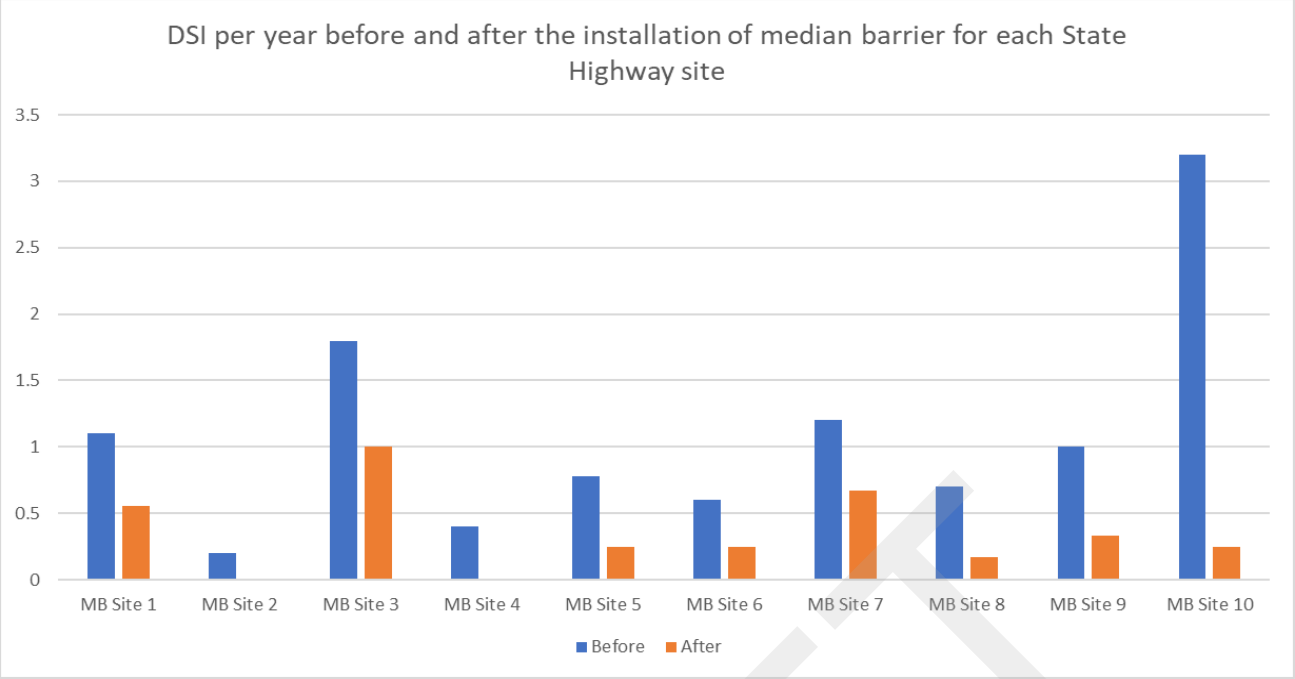

Figure 1. DSI per year pre and post installation of median barrier

Intersection Speed Zone CAS data findings

For the 5-year before and after the implementation period, which is considered more reliable comparing to 10-year period due to fewer confounding factors such as traffic growth, land-use changes, and geometric modifications, 11 sites showed a decrease in DSI, among these, 4 sites achieved a 100% reduction in DSI.

However, 2 sites showed an increase in DSI. The increase at Site 7 was due to two crashes that occurred in 2017, both involving failure to give way, with one occurring on a wet road surface. The increase at Site 14 was the result of a crash involving multiple passengers, also due to failure to give way. Both sites have complex geometric layouts. Overall, for the 5-year assessment period, intersection speed zones resulted in an average reduction of 31% in DSI.

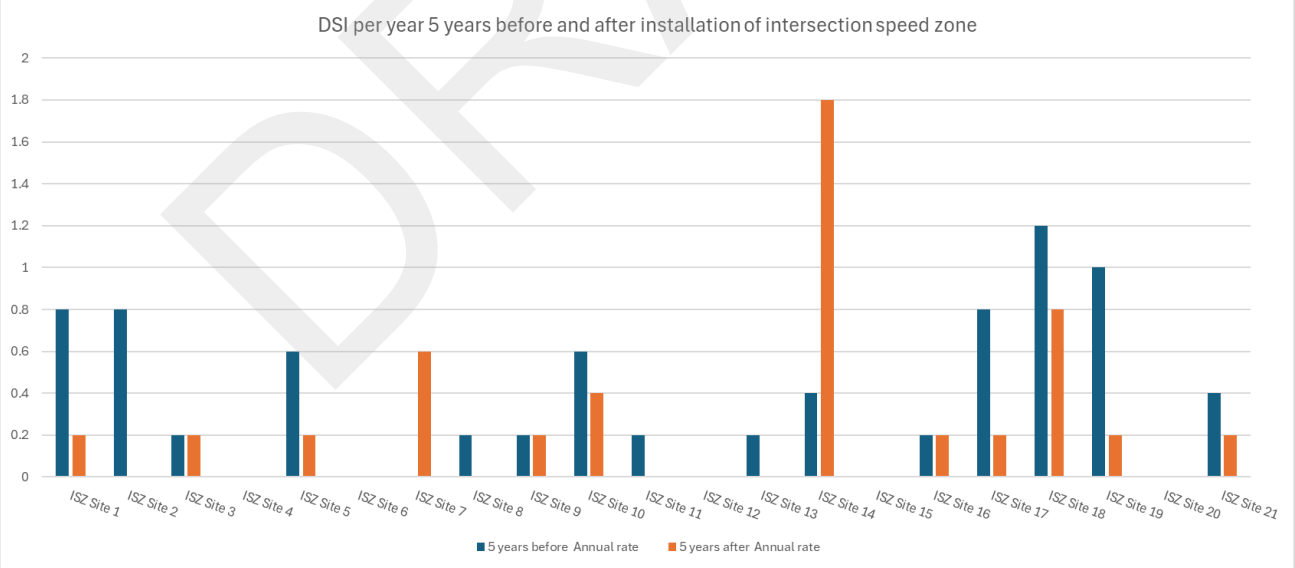

Figure 2. DSI per year 5 years pre and post installation of intersection speed zone

Benefits to road safety

The results of this study highlight the value of systematic post-implementation monitoring in understanding how different road-safety treatments perform in real-world conditions. Median barriers demonstrated a more consistent and predictable safety benefits, with all sites showing a reduction in DSI. This aligns with international and local evidence confirming that median barriers are among the most effective treatments for reducing high-severity crashes (AUSTROADS, 2024). Their performance in this analysis reinforces the expectation that median barriers reliably deliver substantial safety improvements when implemented appropriately.

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However, the findings for intersection speed zones show a mixture of negative and positive outcomes. While many ISZ sites achieved reduction in DSIs, two sites experienced an increase in DSIs following installation due to confusing geometry layouts. This indicates that at some locations in the network, speed alone may not be the primary contributing factor to crash risk. Other elements—such as intersection geometry, confusing layouts, sight-distance limitations, or operational issues—may play just as an important role in resulting in crash occurrence. In such cases, speed reduction may help but this would have to done in conjunction with other safe system treatments.

Additionally, changing external conditions can influence DSI trends. Over time, factors such as traffic growth, changing land use, and deteriorating road condition can increase exposure and risk. These dynamics mean a treatment that initially performs well may become less effective without complementary improvements or ongoing maintenance. The sites where DSI increased after ISZ installation highlight the need for road controlling authorities to undertake further investigation to understand the root causes and to identify whether additional interventions are required.

Implications for policy and practice

The findings have several important implications for future policy development and the management of road safety infrastructure.

- The results show that interventions must be assessed within their broader context rather than viewed in isolation. Site specific factors such as traffic growth, road function, geometric complexity, and surrounding land-use changes play a significant role in treatment performance. Additionally, ongoing monitoring is necessary to identify long-term trends and determine where additional measures, such as geometric upgrades, enhanced signage, or targeted enforcement, may be needed to maintain or improve safety outcomes.
- Post implementation monitoring also provides a stronger evidence base for investment decisions. Demonstrated effectiveness helps strengthen business cases, supports more transparent and defensible funding allocation, and increases confidence among funding partners. Evidence driven approaches maximise road safety benefits and ensure that future funding is directed toward initiatives with proven outcomes.

Conclusions

This analysis demonstrates that regular, ongoing post-implementation monitoring is essential for ensuring that road safety treatments deliver their optimal outcome. Across the network, median barriers consistently produced substantial and predictable reductions in crashes, reinforcing their effectiveness as safety interventions. Intersection speed zones also delivered meaningful benefits in most of the sites, but their mixed results highlight that their wider operational and physical context must be considered. Continuous monitoring enables road controlling authorities to identify where interventions are performing as expected and where additional investigation measures may be required.

Ultimately, this analysis shows that monitoring must be embedded as an ongoing component of safety management, enabling road controlling authorities to refine interventions and build a more adaptive and evidence-responsive approach to reducing incidences across the network.

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Effective use of social media in Police enforcement and engagement.

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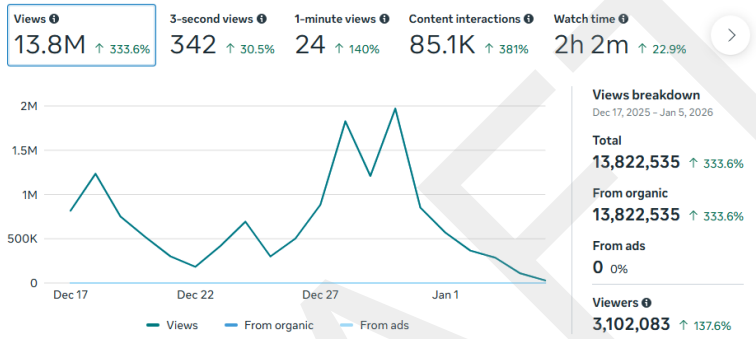
Abstract

The use of social media as a policing strategy in combating the road toll is not a new exercise. By forgoing traditional media, social media directly engages with road users and enables flexible yet targeted messaging, which has proven highly effective. Over the most recent New South Wales Police Force (NSWPF) - Traffic and Highway Patrol Command's (THPC) 2025 Christmas / New Years Operation, targeted messaging reached 13.8 million people, far surpassing the reach of traditional media.



Utilising the success of the platform, the THPC Social Media Coordinator worked to integrate social media strategies within operations conducted by officers. Two successful applications include, "Operation Upright", an operation specifically targeting a rise in motorcycle fatalities, and "NightDrive for Learners", a community engagement program targeted at novice drivers.

Introduction

"Operations Upright"

In January 2022 THPC officers identified a spike in motorcycle fatalities. Between 15th December 2021 and 15th January 2022, 19 motorcyclists lost their lives on NSW roads. An analysis of the collision reports found a common phrase "failed to negotiate bend", meaning they were at fault. The majority of collisions occurred in regional NSW, with the average age of involved riders being 41. Reading online material revealed that most riders blamed other road users or claimed that young and inexperienced riders were at fault. However, the crash data showed the opposite. Rather than launching another enforcement operation targeting riders for offences, officers decided to try a new approach.

After identifying 4 popular motorcycling routes, an operation was proposed that would see Police adopt a three-pronged approach:

1. A targeted Social Media Campaign utilising the THPC's Facebook and Instagram accounts.
2. High Visibility patrols utilising marked police motorcycles and vehicles on the 4 nominated motorcycling routes.
3. Targeted engagement with riders at nominated popular rest spots.

The Operation was scheduled for 4 weekends in February 2022.

"NightDrive for Learners"

In August 2020 while conducting a revamp of the use of Social Media in the THPC, a program was commenced by the THPC Social Media Coordinator in collaboration with Sydney Motorsport Park (a government owned facility), Australian Racing Drivers Club (the not for profit charged with running the facility) and Driving Solutions (a private business contracted to perform driver training and track activities at SMP).

Identifying a shortfall in opportunities for new Learner Drivers to gain valuable experience without other road users, the program gave up to 60 participants along with their supervisors the opportunity to drive around the racetrack at SMP for up to two hours under standard road rules. By creating an environment which did not include the pressures of other road

users, traffic lights or oncoming vehicles, the novice drivers could concentrate on building their confidence in car control at night. The event would begin with a short presentation from experienced Highway Patrol officers and venue experts. While participants were on the circuit, a mock RBT site would be setup in pit lane where drivers could navigate through the site and have a one-on-one conversation with officers.

The results of these conversation and the questions asked are answered and amplified by publishing them on the THPC social media pages.

Conference theme

Operation Upright was born from a quick analysis of relevant data and applying a solution that would not address only one action but a range, offering the best chance of success. NightDrive for Learners was a more contemporary look at issues facing young drivers, not only traffic related, but also housing and economic effects. The impact of a booming housing market takes away spaces for learners to drive without other road users and many learner programs come at high costs, making them inaccessible to many. Offering a free program removes the financial limitation, allowing young people from all demographics to participate. Both programs work directly to the conference theme of *"Evidence to Action: Shaping a Brighter Future*."

Method

Operation Upright.

The significant number of fatal collisions in such a short time frame allowed operation organisers to map out the locations of these collisions and identify four main social motorcycle routes that crossed over these locations. They were, The Royal National Park, The Old Pacific Hwy, The Putty Road and Kangaroo Valley / Macquarie Pass.

These were areas that historically received significant enforcement action from Police. Areas were identified along the routes where riders would regularly stop for breaks/fuel and officers were tasked to stop at peak times and engage with riders. Officers were provided talking points based on the above-mentioned road statistics and given que words and sentences around riding in groups, peer pressure and protective clothing. The focus of the day was for Officers to spend time at these sites and engage with riders to further promote the road safety messaging.

A social media campaign was drafted which spoke directly to the sharp rise in fatalities and shared responsibility for road safety. The posts addressed practical tips around riding in groups and peer pressure, rather than sounding like a traditional campaign targeting speeding. These posts were published in the days leading up to the in-person operation weekend. Officers recorded the number of persons spoken to rather than the amount of penalty notices issued and were given the ability to provide feedback from riders and themselves.

NightDrive for Learners

The program would see up to 60 participants register via a free online portal to take part in the night, which would run the first Tuesday of each month from 6pm to 8pm. Participants with their supervisors would attend at 5:30pm and complete registration and at 6pm would receive a presentation from the THPC officer who created the program. This presentation's focus was on real-life experiences and issues of distractions, peer pressure and critical thinking rather than just the expected information about road crash statistics or trends.

Once this was completed, participants would be guided on to the circuit where they could spend the next two hours developing their road craft and confidence under much safer conditions than on an open roadway. THPC officers would setup a mock RBT site in pit lane where the novice drivers would be "pulled in" the same way they would be on the roadway, teaching them how to navigate an RBT site. Officers would then talk the participants through the RBT/RDT process and have casual conversation about road safety. Common questions asked by participants would be collated and reviewed, directing the way the initial presentation should be structured.

Results

Operation Upright

The operation was run over four full weekends during daylight hours in February 2022. The social media campaign reached more than 6.3 million people over the 16 posts published via the THPC's Facebook and Instagram pages. The comments on the posts were overwhelmingly positive, due to the positive nature of the posts with such a difficult topic.

The returns received from officers in the field provided important information. By the second weekend every second person spoken to at the rest stops had seen the social media posts. This gave officers another opportunity to engage whereby the conclusion of the operation all routes except one (Old Pacific Hwy) had reacted positively to the form of engagements. An analysis of fatal collisions involving motorcycles in the month the operation was run found that fatalities had dropped to 6, significant decrease from the previous 30 day high of 19. This did not follow a specific trend

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from previous years, and the previous years fatal trends were skewed due to the impact of COVID19 on overall vehicle movements.

NightDrive for Learners

The NightDrive for Learners program has run monthly for the past 6 years. The program has a 6-month waiting list for participants to take part, indicating its popularity. Over the past 6 years more than 4,000 young people have taken part in the program. Unknowingly, by seeking out ways to benefit their own knowledge in road safety, participants have contributed significantly to the wider safety of road users in New South Wales.

The conversations had with participants helped shape statewide messaging for the NSWPF THPC social media pages. The monthly program was utilised as a road safety focus group, where the participants and their supervisors covered a large demographic and gave content creators the opportunity to see what the state's road users on different levels required, combined with what statistical information Police were able to perform. Since inception, content specific to the NightDrive for Learners program has reached more than 10 Million users and helped shape social media messaging for the NSWPF THPC.

Due to the shift in content focus and change of posting strategies a significant growth was seen in the reach of the road safety messaging from an average of 2 million people reached a month to 10 million people a month.

What is difficult to measure is the positive impact a wholesome program, run for the right reasons has had on the overall reputation and good standing of all organisations involved. Thanks to the successful engagements made as part of these operations, participants have been given "the why" by professional road safety practitioners. Creating a brighter future for road safety by passing on the message they received by taking part in these initiatives.

Benefits to road safety

Operation Upright had a significant impact on fatal road collisions involving motorcycles. The 30 days before the operation was run, 19 motorcyclists had lost their lives on NSW roads. The following 30 days saw a significant reduction to 6 while the operation ran. The operation had a significant impact via its educational campaign on educating at risk road users on road craft and safety equipment.

NightDrive for Learners also had a significant impact both in a practical sense and educational. Drivers were given the opportunity to build practical road craft skills and the unique opportunity to have a positive conversation and insights into road safety from professional practitioners.

Implications for policy and/or practice

These programs have shown the benefit of integrating education and engagement strategies in road safety operations. The success of these operations has seen social media education campaigns form part of police operations to great success.

Conclusions

Social media has given the NSWPF and THPC a great tool to reach road users directly. No other traditional media or campaigns have had the same level of success in not only reaching millions of road users but having a real world impact on road safety. The primary measure of success in Operation Upright was the sharp decline of fatal collisions involving motorcycles. Social media campaigns are difficult to measure success but the significant uptake of participants for NightDrive for Learners and the positive feedback is a strong indicator that the program is achieving success.

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Biomechanical evidence supporting 30 km/h school-zone speed limits for child safety

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Abstract
Most Australian jurisdictions apply time-dependent 40 km/h school-zone speed limits despite high levels of child pedestrian activity. The Australasian New Car Assessment Program (ANCAP) similarly evaluates pedestrian protection at 40 km/h, providing vehicle-specific head-injury risk indicators. This study assessed the child pedestrian safety performance of Australia's five top-selling vehicles using Head Injury Criterion (HIC) distributions derived from published ANCAP pedestrian data. HIC values were scaled using established velocity–mass–HIC relationships to estimate injury risk across a range of impact speeds. The results demonstrate that the 5 highest selling vehicles in Australia (all SUVs) present substantial predicted child head-injury risk at 40 km/h. Reducing impact speeds to 30 km/h markedly reduced predicted injury probabilities to substantially lower biomechanically injury risk thresholds. These findings provide biomechanical evidence supporting 30 km/h speed limits as an effective measure to improve child pedestrian safety.

Introduction
Most Australian jurisdictions implement school-zone controls as time-dependent 40 km/h limits. He et al., (2024) found that paediatric pedestrian injuries remain unacceptably high even in 40 km/h school zones, suggesting that system-energy in vehicle-pedestrian collisions still exceeds biomechanically tolerable limits for children. Child pedestrian safety is dependent on speeds permitted in school environments, infrastructure or mechanisms aimed at physically reducing traffic speeds and the design of vehicles interacting with vulnerable road users. The Australasian New Car Assessment Program (ANCAP) have been assessing vehicle safety for several decades, and for any pedestrian protection, ANCAP has been the primary mechanism in Australia that has been able to influence manufacturers to improve passive vehicle pedestrian protection in Australia, since there is no legislated vehicle safety standard for pedestrian vehicle safety, even for the most vulnerable of pedestrians, children. Keall et al., (2022) found that improved safety outcomes for pedestrians struck by vehicles with better ANCAP pedestrian ratings, but only when the speed limit was 40 km/h or less. Similarly, Paine et al., (2019) found newer cars reduced serious/fatal injuries for pedestrians, but neither study examined child pedestrian injury risk in isolation.

The current ANCAP pedestrian protection protocol (ANCAP, 2023) requires manufacturers to submit a finite-element representation of the vehicle front structure coded according to Head Injury Criterion (HIC) values across multiple 100 mm × 100 mm grid locations for 40 km/h equivalent headform energy conditions. Each grid point is assigned one of five colour bands corresponding to specific HIC ranges. ANCAP then selects ten random impact locations weighted by the proportion of grid colours and performs physical headform tests at 40 km/h to validate the submitted model and then the grid results are published by ANCAP with the corresponding child and adult head scores.

Figure 1 shows the colours and HIC ranges overlayed with the serious injury risk curves that demonstrate probability of AIS3+, AIS4+ and fatal head injury. A HIC of 650 is the upper most value for green and corresponds to a 22%, 5% and 0.1% probability of AIS3+, AIS4+ and fatal head injury respectively while a HIC of 1000 increases this to 53%, 17% and 1% probability of AIS3+, AIS4+ and fatal head injury respectively.

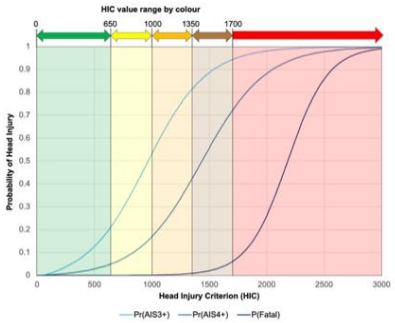

Figure 1. Colours and HIC ranges overlayed with the serious injury risk curves
(derived from ANCAP headform performance bands and Prasad–Mertz head injury risk functions (NHTSA, 2007))

To provide context on the importance of ensuring HIC values being controlled to under 1000 for children, under Australian playground safety requirements, impact-attenuating surfacing beneath playground equipment must be demonstrated through standardised headform testing to produce a Head Injury Criterion (HIC) value not exceeding 1000 when dropped from the equipment's critical fall height, as specified in AS/NZS 4422:2016. If testing produces HIC values above 1000, the surface must be modified or replaced until compliance is achieved. This requirement reflects a safety benchmark for limiting head injury risk to children during playground falls, yet no such requirement exists for vehicles that children are exposed to in school zones.

Conference theme

We present further evidence that 30 km/h is a safer school zone speed limit compared to 40 km/h, it's time to action speed limit reductions in school zones so that we can give school children a brighter future with reduced risks to injury.

Method

Data was extracted from published Australasian New Car Assessment Program reports for the five highest selling vehicles in Australia in 2025, these vehicles represented almost 20% of total sales for 2025. The child pedestrian test results were disaggregated from published ANCAP results and were assigned the mid-point HIC value in each HIC range (a conservate HIC value) so that all green grid points were assigned a HIC value of 325, yellow 825, orange 1175, brown 1525. Red was assigned a value of 1700 represent a lower bound that HIC category. Midpoint values were used as a conservative estimate because the exact HIC values for each grid location are not publicly available. Child head impact locations were defined as grid locations between wrap-around distances (WAD) of approximately 1000–1500 mm, representing the likely head impact region for pedestrians aged approximately 3.5–15 years.

Using the validated velocity-HIC scaling equation from Searson et al (2012): $\mathbf{HIC_2 = HIC_1 \cdot (V_2/V_1)^{2.5}}$

Where HIC_2 is the scaled HIC at the desired speed V_2, HIC_1 is the ANCAP derived test HIC at V_1 the ANCAP test speed of 40 km/h. Each grid point was then scaled according to an impact speed change to 35 km/h, 30 km/h and 45 km/h respectively. Estimated HIC values were then converted to head injury risk functions calculated using the Prasad–Mertz injury probability functions relating HIC to AIS injury severity (NHTSA, 2007).

Results

Figure 2 shows the grid scores for each of the five top selling vehicles as published by ANCAP, disaggregated by child impact area, and then at 35 km/h, 30 km/h and 45 km/h respectively. Table 1 shows various important biomechanical injury risk metrics associated with the HIC distribution for each vehicle at various impact speeds. At 40 km/h the proportion of the HIC < 1000 ranges between 33% to 71% while at 30 km/h each grid point has a HIC <1000. Correspondingly, the probability of a AIS4+ injury (averaged) for a child struck at 40 km/h ranges from 15% to 41% at 40 km/h compared to 2% to 6% at 30 km/h. At 45 km/h the risk of a AIS4+ injury for a child increases to 31% to 61%.

Figure 2. Child head impact locations with HIC values at different impact speeds using ANCAP results.

Benefits to road safety

This research demonstrates the importance of understanding how vehicle design influences child pedestrian safety. The top five selling vehicles assessed in this study and indeed most medium to large SUVs exceed the HIC thresholds

permitted under playground safety standards. In the absence of a federal government vehicle regulation mandating minimum levels of child pedestrian protection, the only mechanism to mitigate the risk is for jurisdictions to lower speed limits in high child pedestrian activity areas (such as school zones) to 30 km/h with additional mechanisms to ensure good compliance.

Table 1. Various averaged biomechanical metrics based on HIC values at different impact speed

Car Rank	40 km/h ANCAP				35 km/h				30 km/h				45 km/h			
	<1000	Pr(AIS3+)	Pr(AIS4+)	Pr(Fatal)	<1000	Pr(AIS3+)	Pr(AIS4+)	Pr(Fatal)	<1000	Pr(AIS3+)	Pr(AIS4+)	Pr(Fatal)	<1000	Pr(AIS3+)	Pr(AIS4+)	Pr(Fatal)
1	53%	54%	30%	2%	69%	35%	12%	0%	100%	17%	4%	0%	16%	70%	48%	18%
2	33%	65%	41%	3%	51%	45%	17%	0%	100%	22%	6%	0%	17%	77%	61%	29%
3	41%	58%	26%	1%	84%	34%	10%	0%	100%	15%	4%	0%	3%	80%	50%	8%
4	71%	39%	15%	0%	92%	22%	6%	0%	100%	10%	2%	0%	28%	57%	31%	3%
5	53%	54%	30%	2%	69%	35%	12%	0%	100%	17%	4%	0%	16%	70%	48%	18%

Implications for policy and/or practice

The results of this study provide biomechanical evidence highlighting the need for increased scrutiny of vehicle design and child pedestrian injury risk. Crashes resulting in 40 km/h head impact speeds are associated with unacceptably high levels of head injury risk for child pedestrians. In the absence of mandated and effective child pedestrian protection standards, the application of 40 km/h speed limits in areas of high child pedestrian activity, such as school zones, does not represent an adequate safe system measure to protect children. Policymakers should prioritize the adoption of lower school-zone speed limits, no greater than 30 km/h, supported by appropriate traffic-calming infrastructure to ensure high levels of compliance

Conclusions

This study demonstrates that the top five vehicles best-selling vehicles in Australia present unacceptably high head injury risks if involved in collisions with child pedestrians at 40 km/h (a very possible scenario in a 40 km/h school zone, with a speed compliant vehicle and the sudden challenge of a child pedestrian running across a road with little or no time to react). The risk of a AIS4+ injury for that child at a 40 km/h impact speed is 15% to 41% with a 0% to 3% chance of a fatal head injury. For a non-speed compliant vehicle travelling only 5 km/h over a 40 km/h school zone speed limit with same child pedestrian challenge, the risk of a AIS4+ injury for a child increases to 31% to 61% with a 3% to 18% chance of a fatal head injury. At 30 km/h the risk of a AIS4+ injury for a child is 3% to 6% and less than 0.03% chance of a fatal head injury. While it is argued that active safety systems such as Autonomous Emergency Braking (AEB) should reduce impact speeds or even prevent collisions with child pedestrians, reliance on AEB alone cannot guarantee protection due to known detection and scenario limitations. AEB can fail, AEB is not optimised for the spontaneous, erratic child pedestrian behaviour and movement and is not tested in school zone traffic areas. Corben et al., (2022) stated that "… the travel speeds of vehicles that interact with children and their families on school-related journeys must be secured to 30 km/h or lower, to ensure the safety of children walking or cycling to school...". The present study demonstrates the scientific validity of 30 km/h as a more appropriate school zone speed limit compared to 40 km/h.

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From evidence to action: supporting safer booster seat decisions

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Abstract
Parents often struggle to judge when it is safe for children to transition from booster seats to adult seatbelts, a decision complicated by inconsistent guidance, knowledge–behaviour gaps, and legislation permitting seatbelt use from age seven. To address this, a three-phase program of research applied the Behaviour Change Wheel and COM-B model, incorporating evidence review, behavioural diagnosis, user engagement, and iterative testing to develop a user-centred digital decision-support tool. Formative studies identified key behavioural tasks and parent barriers, informing prototype design. Across iterative refinement, decision-making accuracy improved from 40% to 90%, with high knowledge and strong message fidelity. Real-world testing demonstrated strong comprehension, high usability ratings, and good accuracy in identifying safe and unsafe fit conditions. The resulting prototype website offers clear road-safety benefits by supporting more accurate restraint decisions and demonstrates potential for broad, equitable access once implemented. These outcomes have practical implications for reducing crash-related trauma among children aged 7–12.

Background
Parents frequently struggle to convert available road safety information into sound judgements about when to transition children from booster seats to adult seatbelts (Powell et al., 2025). This disconnect between knowledge and behaviour carries serious consequences, as premature transitions markedly increase children's injury risk (Brown et al., 2006). Adding to this complexity, Parab et al., (2022) demonstrate that no single metric, such as height or weight, can reliably determine readiness for an adult seatbelt. The Australian regulatory environment further complicates decision-making, with legislation permitting adult seatbelt use from age seven (New South Wales Consolidated Regulations, 2014), despite best-practice guidance recommending individual fit assessments (Neuroscience Research Australia & Kidsafe, 2020).

The Behaviour Change Wheel and its COM-B model (Michie et al., 2011) provide a robust framework for understanding the barriers and facilitators to child restraint use and develop theory informed interventions, an approach supported by previous research in the field (Hall et al., 2016). Consumer engagement principles similarly highlight the importance of involving end-users directly in resource development to ensure interventions reflect real-world needs and contexts (Gray-Burrows et al., 2018). User-centred design has proven particularly effective in child restraint interventions, with parent involvement yielding a significant 27% improvement in correct restraint use ($p = .042$) (Hall et al., 2020). Yet, despite these well-documented challenges, no validated, user-informed tools currently exist to guide parents through this high-stakes transition, leaving a critical gap in child occupant protection.

Conference theme
This research translates behavioural evidence into a practical, user-centred intervention that directly supports safer child restraint decisions, aligning with the conference theme of moving from evidence to action.

Method
To address these identified gaps, a three-phase research program was undertaken, integrating systematic evidence review, behavioural diagnosis informed by the Capability, Opportunity, Motivation and Behaviour (COM-B) model, and intervention development guided by the Behaviour Change Wheel (BCW). Across the formative, prototype, and evaluation phases, six interconnected studies were conducted to examine how parents determine readiness for transitioning from booster seats to adult seatbelts, and to develop a theory-informed, user-centred decision-support tool. See Figure 1.

Phase 1 focused on establishing a behavioural evidence base. Literature and systematic reviews confirmed the relevance and applicability of COM-B and the BCW in injury-prevention contexts and highlighted persisting knowledge–behaviour gaps in child occupant protection. A randomised controlled trial of the existing 5-step test was then conducted to benchmark current resources. To explore underlying cognitive processes, think-aloud assessments with parent–child dyads were then mapped to the BCW functions. These findings were complemented by focus groups to understand knowledge deficits, peer comparison, inconsistent parental confidence, and child resistance.

Phase 2 centred on intervention development, combining structured behavioural analysis from Phase 1 with consumer panel input and health literacy expertise to co-design a theory-driven digital decision aid that was iteratively refined to maximise clarity, feasibility, and alignment with user preferences. Phase 3 progressed to iterative user testing to assess comprehension and task performance, with successive refinements made until an 80% decision-accuracy threshold was consistently met. Finally, a real-world evaluation with parent–child dyads assessing seatbelt fit in their own vehicles provided ecological validation of both the usability and practical effectiveness of the decision-support tool.

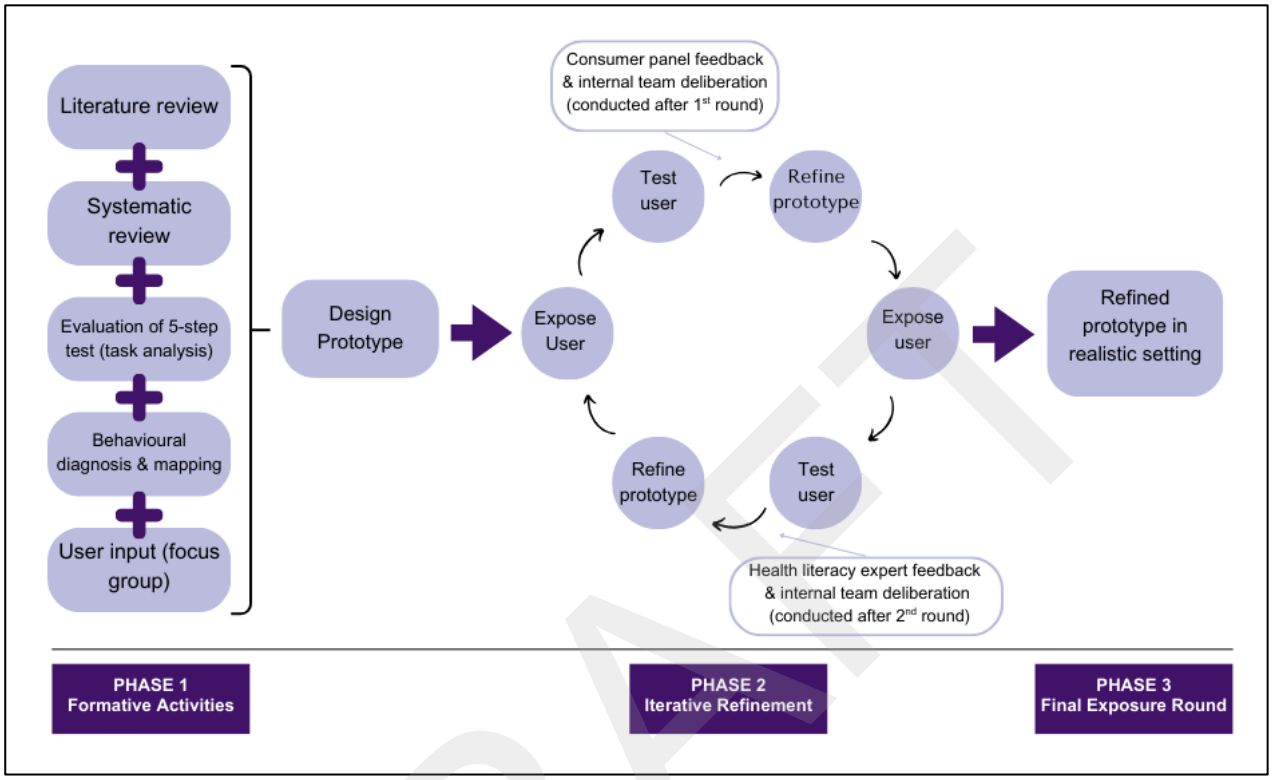

Figure 1. Design Process of Prototype Intervention with Formative Activities, Iterative Refinement and Final Exposure

Results

Result of the five formative studies that comprised Phase 1 generated a comprehensive behavioural evidence base to guide prototype development. Reviews confirmed persistent premature transitions from boosters and supported the value of theory-driven, user-centred interventions. Evaluation of the existing 5-step test showed increased knowledge but unchanged decision accuracy, highlighting the need for enhanced supports that bridge understanding and application. Think-aloud assessments identified 17 essential tasks across five domains required for assessing safe seatbelt fit, while focus groups revealed influential behavioural factors—including knowledge gaps, social comparison, parental confidence, and child comfort. These combined insights directly informed the structure, messaging, and behaviour change techniques integrated into the initial prototype.

Across three rounds of iterative testing (Phase 2), progressive refinements strengthened clarity, usability, content sequencing, and message fidelity. Key improvements included simplifying language, reorganising criteria into an intuitive head-to-toe flow, refining visual cues, and addressing elements that caused confusion in earlier rounds. Decision-making accuracy increased steadily from 40% in Round 1 to 70% in Round 2 and exceeded the 80% requirement in Round 3, with 90% of participants correctly identifying all seatbelt fit conditions. Knowledge remained consistently high throughout, and message fidelity reached 94% in the final round. With all predetermined performance thresholds achieved, the prototype was finalised for real-world testing. The finalised prototype was adapted into a website for Phase 3.

In real-world assessments conducted with parent–child dyads in their own vehicles (Phase 3) evaluating the developed website, 60% of participants correctly classified all fit conditions. Knowledge acquisition was strong, with all participants scoring ≥90% and an average score of 94%. Acceptability testing indicated generally positive attitudes, high comprehension, and strong perceived usefulness, although some participants noted concerns around resource length and navigation. Quantitatively, participants rated the intervention as highly useful, easy to understand, and confidence-building in terms of their ability to assess seatbelt fit.

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Benefits to road safety

These results demonstrate clear road safety benefits through the development of a user-informed website that will, once made publicly accessible, support parents in making safer restraint decisions and offer the potential for equitable access to best-practice guidance.

Implications for policy and/or practice

The outcomes of this work will help reduce road-crash trauma by supporting parents to keep children in booster seats until they achieve a safe seatbelt fit, meaning children aged 7–12 will be safer on Australian roads.

Conclusions

This study is the first to systematically examine both the informational needs and behavioural drivers underlying parental decisions about booster seat transitions. Results demonstrate that well-designed, theory-informed tools can meaningfully reduce premature transitions, while also exposing the shortcomings of conventional educational strategies for addressing complex safety behaviours. The three-phase methodology offers a replicable framework for future child safety intervention work, though the findings suggest that even rigorously developed, user-informed tools may need to be paired with broader policy and infrastructure initiatives to drive change at a population level. Overall, this research deepens understanding of the knowledge-behaviour gap in child passenger safety and provides a foundation for more effective, real-world transition support tools.

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A practical response to embed local government road safety accountability

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Abstract
Effective road safety outcomes depend not only on technical analysis, but also on governance arrangements that shape how decisions are made and resources allocated. This paper examines the relationship between shared accountability across government levels and road safety funding prioritisation at the local level with a particular focus on regional councils, using mixed-method design. Publicly available NSW Road safety grant programs are analysed, showing mixed funding outcomes for regional, rural and remote councils. The NSW Integrated Planning and Reporting Framework that mandates council planning does not direct road safety goals and outcomes but requires extensive community input into council planning. Analysis of Community Strategic Plans reinforces inconsistencies in alignment with state and federal road safety targets. We propose an integrated model linking shared accountability with proactive prioritisation frameworks, incorporating predictive risk indicators and structured community input, supported by road safety goals and outcomes reporting.

Introduction
Councils control 80-90% of the road network, which accounts for over half of all casualty crashes. Where location and road classification are known (around 70% of crashes) council roads represented $3.1B in road trauma costs annually (NSW Govt, 2021, 2019 dollars). Regional and rural councils face well recognised challenges - lower traffic volumes, more dispersed crashes and reporting lags, limited resources (Austroads, 2020; ITF, 2020; NSW Auditor General, 2023). This often leaves councils excluded from funding, as traditional prioritisation relies on high crash frequencies and severity, not risk factors. A proactive safe systems approach and complex risk assessments remain difficult for councils (McTiernan, 2019; ACRS, 2024).

Achieving a Safe System requires shared responsibility, yet effective governance frameworks are challenging (Breen & Shelton, 2019). Councils are expected to deliver road safety outcomes without influence over funding criteria, or prioritisation. The current funding model contrasts with the NSW Integrated Planning and Reporting Framework (IPR) which prioritises risk factors and community insight. Funding protocols result in limited opportunities to combine these two seemingly alternate prioritisation methods. This work aims to:

a. Describe the status of road safety funding allocations, focused on NSW regional councils.
b. Investigate NSW government requirements that drive local council delivery and reporting.
c. Suggest practical, incremental governance improvements for regional, rural and remote councils, combining risk factors (e.g. community risk and crash data) for a framework for equitable investment accountability.

Conference theme
Practical measures to improve shared responsibility for road safety in rural and regional areas. Integrating community safety intelligence into funding is an innovative way to engage community as road safety advocates.

Method
Analysis of funding allocations for NSW regional, rural and remote councils found limited, fragmented published data. Programs in the last 5 years, with published criteria and allocation were analysed, from TfNSW:

- Road Safety Program ($90.2m, 2023-24 to 25-26) – risk-based criteria, iRAP assessment tool, competitive.
- School Safety Infrastructure sub-program ($39.5m 2020-Feb2025)– regional and rural councils are eligible.
- Blackspot Program ($38.8m 2024-25, $59.9m 2025-26) - crash history, assess BCR (regional and rural crashes have lower thresholds), competitive.
- Get Active Program ($59.7m 2024-25, $58.7m 2025-26) - safety component, competitive process, 40% funding prioritisation allocation for regional and outer metro councils.

NSW Fatal and Serious Injury (FSI) crash data for local councils over a five-year period (2020-2024) were accessed, and ABS Category and council characteristics from Office of Local Government (OLG).

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Desktop review of IPRs, and sample of 25 council Community Strategic Plans (CSP), (OLG category by highest FSI total crashes over five years) reviewed for evidence of road safety goals (if any) in council planning.
Inputs to develop proposed governance improvements. A desktop review of key national and international guidance on risk-based proactive (lead) performance measures for safe systems approaches was conducted.

Findings

Table 1 shows an overview of the total funding from each of the four programs. At a macro level, most councils have received funding, noting that the proportion is lowest for large rural councils.

Table 1: Overall council funding allocation by FSI crashes (total # over 5 years) and OLG classification

OLG Classification	Metropolitan	Metropolitan Fringe	Regional Town/ City	Large Rural	Rural
# of LGAs	25	9	37	42	15
% Councils get funding from (1+) programs	92%	89%	100%	74%	93%
Total funding allocated	$119,645,446	$57,261,658	$124,005,861	$29,239,741	$16,699,495
Av funding per LGA	$5,201,976	$7,157,707	$3,351,510	$943,217	$1,192,821
Minimum funding grant	$0	$0	$53,236	$0	$0
Maximum funding grant	$22,706,970	$11,642,603	$10,542,673	$5,246,066	$7,873,156
# FSI Crashes over 5 yrs	8,320	3,440	6,974	1,925	297

Source: Transport for NSW Grant announcements, OLG LGA classifications, TfNSW Crash Data

A correlation analysis found a moderate positive relationship between total funding and FSI crashes (Pearson r = 0.406), suggesting councils with higher FSI tend to get more funding, though with substantial variation. Interpretation should be cautious: funding reflects many programs rather allocation linked to crash history.

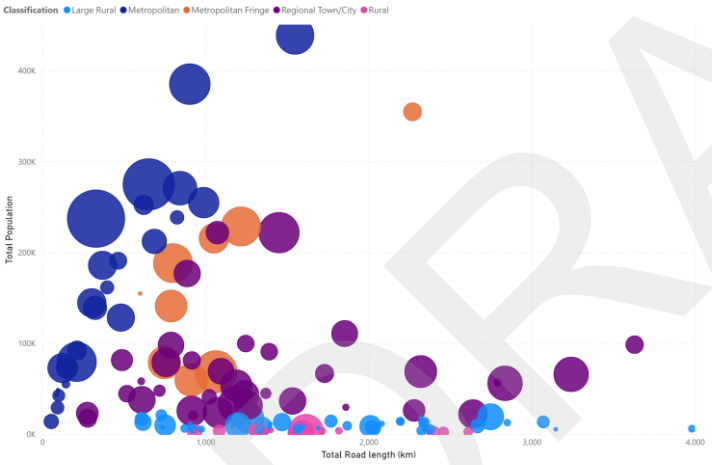

Figure 1 (left): LGA Road length (km) and total population by LGA and classification
Bubble size represents total funding

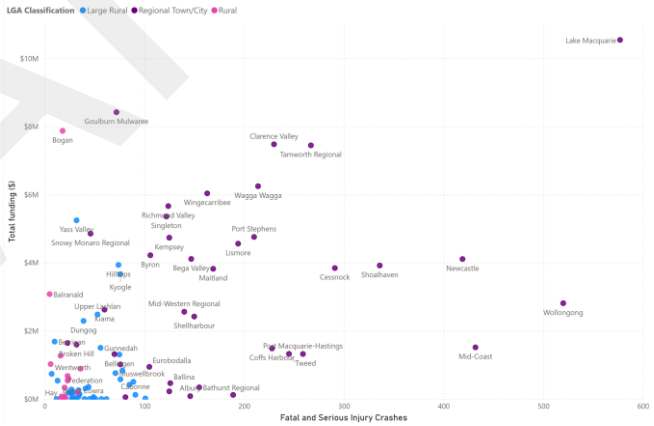

Figure 2 (right): FSI crashes and total funding by LGA and classification (Regional town/city, large rural and rural only)

Source: Transport for NSW Grant announcements, OLG LGA classifications, OLG Your Council Report 2023/24

Figure 1 shows most LGAs of the same OLG classification cluster together, and that metropolitan LGAs with shorter road lengths receive higher funding. Figure 2 shows a cluster of rural and large rural LGAs that receive little funding and have relatively low FSI counts. There does not appear to be a clear relationship between FSI crashes and receiving greater funding. Figure 3 shows many LGAs received no funding from each program. The analysis of available information revealed challenges related to grant tracking, governance, decision-making processes, and funding allocation. The accessible data on funding provides evidence of challenges for equity outcomes, especially reaching regional, rural and remote councils to support safety outcomes.

Councils must consult communities on local priorities, risks, and service outcomes, shown in CSP and delivery plans (NSW OLG, 2021). However, IPR frames roads management and service levels, not safety risk, so proactive safety intelligence is not linked to safety decision-making. The 25 Council CSPs sampled showed few councils had direct road safety goals or measures, notably for large rural and rural councils.

Structured community input is a lead indicator of system risk. Guides show benefits of proactive observational and qualitative lead data (e.g., PIARC, 2025). For example:

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- Community reports of near misses, unsafe crossings, poor sight lines help prioritise road safety audits, inspections, and AusRAP assessments, particularly where crash data does not yet justify action.
- Perceived speeding and community concern consistently emerge earlier than crash data. When combined with speed compliance monitoring, these act as early warning indicators of safe system misalignment.
- Near-miss reporting, observations of risky behaviour and feedback from vulnerable road users provide critical insight into exposure and conflict patterns that are otherwise under-reported in crash datasets.
- Community input supports governance principles such as transparency and shared accountability.

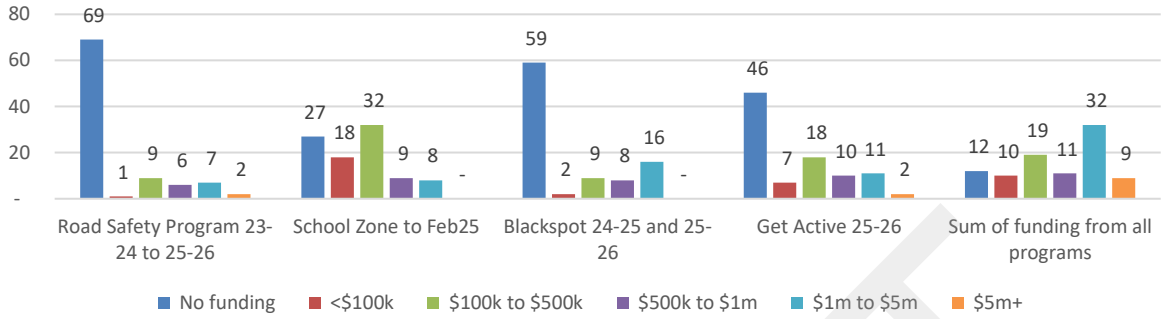

Figure 3: Number of regional town/city, large rural and rural councils receiving program funding and total funding awarded.
Source: Transport for NSW Grant announcements, OLG LGA classifications.

Councils face structural limits in delivering Vision Zero outcomes, these can be in part addressed:

- Introduce road safety as a strategic focus of the IPR to drive council accountability and delivery, creating better alignment with state strategic planning and council planning.
- Councils and State funders to recognise community input as a legitimate lead indicator of system risk, particularly for local councils operating in low crash data, population and travel demand environments.
- Local Councils could be compelled to apply a road safety lens to the management and reporting of community data if some key requirements were to be included in the IPR.

A road safety grant funding assessment tool kit is suggested to support incremental change. This practical, simple, transparent tool kit promotes equitable investment. Existing funding criteria stay in place, proactive community data can be added according to council qualities (e.g., size, population and density, travel needs).

Benefits to road safety.

Embedding shared safe system responsibility and driving delivery through IPR and equitable investment decision-making will improve road trauma outcomes, especially for rural, regional and remote areas.

Implications for policy and/or practice.

This paper applies to road investment decision-making and prioritisation and considerations of effective governance, to improve road safety practice.

Conclusions

'Shared responsibility' is difficult and appears tokenistic when funding models are not fit-for-purpose for regional, rural and remote councils. Rich community intelligence from IPR could be linked to road safety investment decisions. Next steps are for state and local government to collaborate to develop and refine the proposed assessment tool and test it.

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Following-distances: are they enough for you?

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Abstract
The time between vehicles in traffic flow is negatively associated with crash risk. Educational material for drivers includes broad recommendations on what constitutes an appropriate (safe) following distance. A survey of light and heavy vehicle drivers in Australia was undertaken to gauge alignment between these recommendations and drivers' perceptions of an appropriate following distance under different driving conditions. Drivers generally agreed with the recommendations; most believed that larger values were appropriate, particularly drivers of heavy vehicles. There may be misalignment between guidelines and perceptions, yet the ongoing prevalence of rear-end crashes suggests there is an attitude-behaviour gap that may be contributing to crash risk. Communicating a more Safe System aligned measure related to following-distance may support translation from attitude to behaviour, and one that may better align with the principle of probable human error.

Introduction
The following distance is the nominal free space or gap between two vehicles in traffic. It can be expressed as the distance between the rear and leading edge of two vehicles in the same traffic stream (Vicroads, 2018), yet more commonly as the difference (distance) in time (Biswas et al., 2021). A shorter distance implies a reduced time to react to safety-critical events, thereby increasing crash risk and crash energy.

Australian education material recommends a two-to three-second following distance for general driving and increasing it when driving a heavy vehicle (HV) or in unfavourable road conditions, such as poor weather and/or reduced visibility (NSW Government; QLD Government, 2015; Vicroads, 2018; WA Government, 2025). Novice drivers are advised to increase this gap to account for inexperience. Whilst the recommended following-distance values are intended to encourage safe driver behaviour, they are derived from perception-reaction times that reflect relatively normal driving rather than a meaningful proportion of the latent perception-reaction times in the system. The guidelines also offer little information on the safe following distance for heavy vehicle drivers, although a following distance of at least four seconds is generally recommended (e.g., QLD Government, 2015).

The aim of the survey was to better understand the extent to which drivers agree with recommended guidance around following distance, and the factors that may influence their choice of following distance. Workplace drivers of LVs and HVs were the focus, although the survey included regular drivers. The survey findings will inform communications and education resources for a national collaborative road safety program, targeting the driver population and the understanding of following distance.

Conference theme
This study addresses the conference theme, *From Evidence to Action: Shaping a Brighter Future*, by examining how closely following-distance recommendations align with drivers' perceptions of an appropriate following distance under different driving conditions. The findings will inform the development of targeted communications and educational resources to better translate evidence into practice.

Method
An online survey was used to ask adult drivers in Australia to select an appropriate following distance in different scenarios and to identify factors that influence stopping distance. They were asked to state their level of agreement with following-distance recommendations (e.g., at least 2-3 seconds) and to nominate their preferred following distance in different conditions. The survey was developed in Qualtrics and took approximately 12-15 minutes to complete. Institutional ethics approval (ID: 45411) was granted to distribute and analyse the online survey. Participants were directed to the explanatory statement, consent form, and online survey via a web link or QR code. The survey was conducted from 5 November 2024 to 2 January 2025.
Descriptive statistics and logistic regression were used to test differences in the level of agreement of driver characteristics with statements related to following distance. Following-distance information was based on material published by state licensing agencies. Differences in agreement were expressed as odds ratios with 95% confidence intervals.

Findings

The survey received 1018 responses, and 764 participants were eligible. Participants' ages ranged from 18 to 87 (mean = 55.8 ± 15.2); a large proportion identified as Male (71.3%); and most resided in Victoria (45.4%). Workplace drivers accounted for 66.2% of participants (10.2% HV drivers and 56.0% LV drivers), and 34.8% were non-workplace drivers. The majority of participants were mature in age (61.8%; 25-64 years).

Table 1 shows general agreement with the minimum following-distance recommendations. There was greater agreement with the values recommended for normal driving conditions (>80%) than for other conditions. The regression analysis found only minor differences in agreement between driver populations (Figure 1). Male drivers were less likely to agree that a gap of at least five seconds is appropriate when travelling at high speeds (OR 0.59; 95% CI 0.40 to 0.87). Mature drivers were less likely than younger drivers to agree that an additional one second for every three metres of trailer was appropriate (OR 0.32; 95% CI 0.11 to 0.93). There were no other significant differences in agreement between driver conditions.

Figure 2 illustrates the cumulative percentage of participants who nominated specific following distances under different driving conditions. There was a high level of agreement among LV drivers across all conditions, and HV drivers nominated higher values than LV drivers in all conditions. In dry, daytime conditions, around 75% of LV drivers preferred to maintain a following distance of at least three seconds. This is at the higher end of the recommendations from state licensing agencies. Around 75% of HV drivers preferred a five-second gap. The preferred distance increased as driving conditions worsened. Under the poorest driving conditions (dark and wet), 75% of LV and HV drivers nominated a preferred following-distance of six-seconds and nine-seconds, respectively. All drivers reported following distances should be more conservative than the published recommendations.

Benefits to road safety

The outcomes of the study will inform communications and education resources for a national collaborative road safety program.

Implications for policy and/or practice

Recommendations are well understood by the participants in the survey; however, the recommendations may not align with what participants think are adequate, following distance- believing that following distance recommendations are below what is necessary in a safety critical event.

Conclusions

Although workplace drivers were expected to demonstrate a greater understanding of following distance recommendations, all driver populations showed a high level of agreement and tended to adopt more conservative distances than the minimum guidance. Despite this, rear-end crashes continue to be pervasive, underscoring that minimum following-distance recommendations, such as those issued by state agencies, are insufficient within a Safe System framework, as they place sole responsibility on drivers and fail to account for human fallibility, distraction, and the multifactorial nature of rear-end crashes. Greater headway reported by heavy vehicle drivers likely reflects awareness of increased stopping distances and requirements such as Australian Road Rule 127, but following distance alone addresses only one element of a broader systemic safety challenge.

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Table 1 Participant agreement with following-distance recommendations - When defining 'adequate following distance', please rate your level of agreement with the following statements

Statements	Agreement	Workplace Driver: Light Vehicle		Workplace Driver: Heavy Vehicle		Non-workplace Driver	
		%	N = 425	%	N = 76	%	N = 271
Keeping a gap of at least 2 to 3 seconds between myself and the vehicle in front	Agree	88.0	374	80.2	61	86.8	235
Keeping a gap of at least 4 seconds when there is bad weather or poor lighting	Agree	84.8	357	77.6	59	86.7	235
Keeping a gap of at least 5 seconds when travelling at high speeds	Agree	72.0	306	72.4	55	73.8	200
Keeping a gap of an additional 1 second for every 3 metres of trailer	Agree	73.1	310	63.2	48	66.4	180

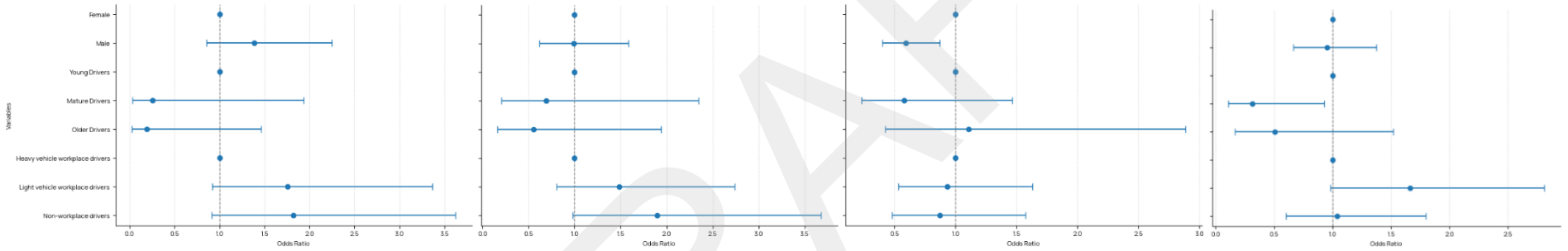

Figure 1 Odds ratio plots with 95% confidence intervals a) Keeping a gap of at least 2 to 3 seconds between myself and the vehicle in front, b) Keeping a gap of at least 4 seconds when there is bad weather or poor lighting, c) Keeping a gap of at least 5 seconds when travelling at high speeds, d) Keeping a gap of an additional 1 second for every 3 meters of trailer

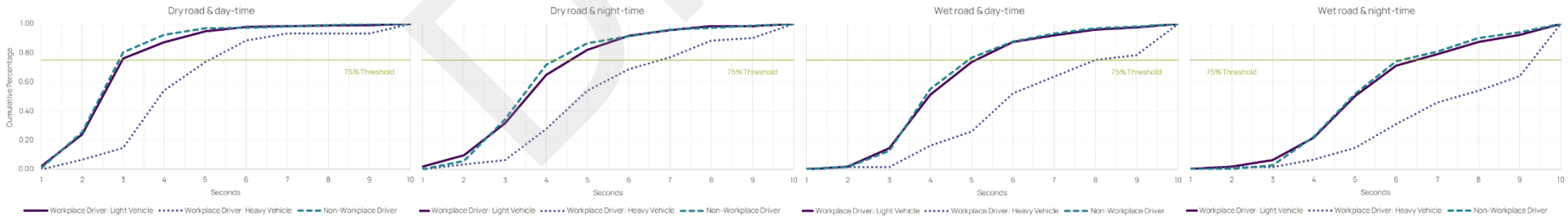

Figure 2 Quantifying stopping distances based on conditions by driver populations for a light vehicle ahead

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Temperature and head injury risk among motorcyclists in Taiwan

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Abstract
Motorcyclists account for a large share of road traffic injuries in Taiwan, yet the influence of ambient temperature on injury outcomes is not well understood. This study examined the association between ambient temperature and head injuries among motorcyclists and the role of risky riding behaviours. We analysed 2,630,492 motorcycle crashes recorded in the Taiwan National Traffic Crash Dataset (2018–2024), linked with meteorological data. Logistic regression models estimated adjusted odds ratios for injuries. Lower temperatures were associated with higher injury risk, while extreme heat increased injury likelihood when crashes occurred. Unhelmeted and alcohol-impaired riding were strongly associated with head injuries, particularly in high temperatures. These findings highlight the need for seasonally targeted road safety interventions.

Introduction
Motorcyclists represent one of the most vulnerable road user groups worldwide and account for a substantial proportion of traffic-related injuries and fatalities. In Taiwan, motorcycles are a dominant mode of transportation, with more than 14 million registered motorcycles, contributing to a high burden of traffic crashes and injuries. Motorcyclists account for approximately 60% of road traffic fatalities in the country, with head injuries being among the most severe and common outcomes due to the limited physical protection available to riders

Environmental conditions, particularly ambient temperature, have increasingly been recognized as important determinants of road safety. Previous studies have shown that extreme temperatures may influence crash risk and injury severity through physiological stress, fatigue, and impaired cognitive performance. However, evidence regarding the relationship between temperature and motorcycle injury outcomes remains limited, especially regarding how environmental conditions interact with risky riding behaviours such as alcohol-impaired riding and helmet non-use.

Understanding these combined effects is particularly important in subtropical regions such as Taiwan, where temperature fluctuations are common and motorcycle use is widespread. Therefore, this study examines the association between ambient temperature and head injuries among motorcyclists in Taiwan and evaluates whether risky riding behaviours modify this relationship.

Conference theme
This study contributes to the ARSC2026 theme “From Evidence to Action: Shaping a Brighter Future” by providing evidence on how environmental conditions and risky riding behaviours jointly influence motorcycle injury outcomes. By identifying temperature-related risks and their interaction with rider behaviours, the findings support the development of targeted road safety strategies, including seasonally focused safety campaigns, helmet enforcement, and alcohol control measures to reduce motorcycle-related head injuries.

Method
This population-based study analysed motorcycle crashes recorded in the Taiwan National Traffic Crash Dataset from 2018 to 2024. The dataset includes nationwide police-reported crashes with information on crash circumstances, vehicles, and injured persons. Meteorological data were obtained from the Central Weather Bureau and linked to crash records using crash date, time, and location.

Motorcyclist crashes with complete information on temperature and rider characteristics were included. The final dataset comprised 2,630,492 crashes. Ambient temperature was categorized into three levels based on local climate thresholds: low (≤16 °C), moderate (17–35 °C), and high (≥36 °C).

The primary outcome was head injury. Risky riding behaviours included unhelmeted riding and alcohol-impaired riding (BAC >0.03%). Multivariable logistic regression models were used to estimate adjusted odds ratios (AORs) for head injuries and to examine the associations between temperature, risky riding behaviours, and their combined effects. All analyses were conducted at a 95% confidence level.

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Results

Among 2,630,492 motorcycle crashes, 28,126 (1.07%) involved head injuries. Compared with moderate temperatures (17–35 °C), low temperatures (≤16 °C) were associated with a higher likelihood of head injuries (AOR = 1.36; 95% CI: 1.18–1.56), whereas high temperatures (≥36 °C) were associated with a lower overall risk (AOR = 0.83; 95% CI: 0.71–0.97). Continuous analysis showed that each 1 °C increase in temperature was associated with a 1.1% decrease in head injury risk overall.

However, within high-temperature conditions, increasing temperature was associated with a higher injury risk (OR = 2.13; 95% CI: 1.09–4.15), suggesting a non-linear relationship between temperature and injury risk.
Risky riding behaviours were strongly associated with head injuries. Unhelmeted riding significantly increased injury risk across all temperature bands, with the highest risk observed during high-temperature conditions (AOR = 5.05; 95% CI: 2.39–10.65). Alcohol-impaired riding was also strongly associated with injuries, particularly under low-temperature conditions (AOR = 7.14; 95% CI: 6.83–7.46).

Overall, ambient temperature and risky riding behaviours independently and jointly influenced the likelihood of head injuries among motorcyclists.

Table 1. Adjusted odds ratios for head injuries among motorcyclists by temperature bands and risky riding behaviors (n = 2,630,492)

Variable		AOR	95% CI	p value
Temperature	Moderate (17–35 °C)	Ref		
	Low (≤16 °C)	1.360	1.184 – 1.561	<0.001
	High (≥36 °C)	0.829	0.71 – 0.969	0.018
Helmet use	Helmeted	Ref		
	Unhelmeted	1.858	1.773 – 1.948	<0.001
Alcohol use	Not drunk	Ref		
	Drunk	5.956	5.696 – 6.227	<0.001

Table 2. Adjusted odds ratios for the combined effects of risky riding behaviors and temperature bands on head injuries

Variable		Low temperature (≤16°C)		p value	High temperature (≥36°C)		p value
		AOR	95% CI	AOR	95% CI	AOR	
Helmet use, n (%)	Helmeted	Ref		Ref		Ref	
	Unhelmeted	2.093	1.765 – 2.482	5.046	2.394 – 10.650	5.046	<0.001
Alcohol use, n (%)	Not drunk	Ref		Ref		Ref	
	Drunk	7.138	6.827 – 7.463	3.983	1.893 – 8.380	3.983	<0.001

Benefits to road safety

This study contributes to improving road safety outcomes by providing evidence on factors associated with road crash risk and road user behaviour. By identifying key determinants influencing road safety, the findings support the development of targeted interventions aimed at reducing risky behaviours and improving compliance with traffic regulations.

The results can assist road safety authorities and policymakers in designing evidence-based strategies to mitigate crash risk and reduce road trauma. In particular, the findings may inform the design of targeted education campaigns, behavioural interventions, and enforcement strategies that address the specific factors identified in this study.

Overall, the study contributes to strengthening the evidence base needed to support effective road safety initiatives and promote safer road environments.

Implications for policy and/or practice

The findings of this study have several implications for road safety policy and practice. First, the identified factors associated with road safety outcomes highlight the importance of targeted interventions aimed at addressing behavioural and environmental risks on the road. Policymakers may use these insights to refine road safety policies and develop more effective prevention strategies.

Second, the results may inform the development of educational and awareness programs designed to improve road user knowledge and attitudes toward safe driving practices. Strengthening such programs may contribute to reducing risky behaviours and promoting safer driving culture.

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Finally, the findings may support the implementation of evidence-based road safety policies and enforcement measures aimed at reducing the incidence and severity of road crashes. Integrating these findings into road safety planning may ultimately contribute to reducing road traffic injuries and fatalities.

Conclusions

This study provides important insights into factors influencing road safety outcomes and highlights key areas where targeted interventions may reduce road crash risk. The findings contribute to the growing body of evidence supporting behavioural, educational, and policy-based approaches to improving road safety.

Future research should further investigate these factors in larger and more diverse populations and evaluate the effectiveness of interventions designed based on these findings. Strengthening the evidence base will support the development of more effective strategies to reduce road traffic injuries and fatalities.

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DRAFT

GAN-based prediction of pedestrian road safety via urban functionality

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Abstract
Pedestrian safety is shaped not only by road design, but also by where daily destinations are located and how people move between them. This study develops a visual modelling framework using a generative adversarial network (GAN) to estimate pedestrian-versus-vehicle crash density under different urban activity patterns in Auckland, New Zealand. The model translates maps of land use, points of interest (POIs), and commuting distance into predicted crash-density maps. Scenario tests show that predicted crash density varies across the central business district (CBD), sub-centres, and residential areas. In the CBD, more public open space was associated with lower predicted crash density, with reductions of up to 14.7%. In sub-centres, high combined concentrations of education-related, commercial, and transport POIs were associated with a sharper predicted increase, up to 80.4%.The framework provides a scenario-based visual tool to support pedestrian safety planning before land-use changes are implemented.

Introduction
Pedestrian road safety is a central concern in urbanising cities. According to the World Health Organization (2023), pedestrians and cyclists account for more than one-quarter of global road traffic fatalities, with strong impacts in urban areas where pedestrian-vehicle interaction is frequent. As cities encourage walking and other sustainable travel modes, they also need to ensure that increased pedestrian activity does not lead to higher crash risk.

Previous research has shown that the built environment is closely related to pedestrian crashes. Land use and points of interest (POIs), such as schools, shops, transport stops, and public facilities, influence where people walk, stop, cross, and interact with vehicles (Ewing et al., 2016; Cai et al., 2022). Dense mixed-use environments can shorten travel distances and support walking, but they can also increase the number of locations where pedestrians and vehicles meet (Sung et al., 2022). Commuting distance may also shape this relationship by influencing travel mode choice and travel exposure (Merlin et al., 2020). However, these relationships are not simple or uniform. The same land-use pattern may have different safety outcomes in different urban contexts.

Most modelling studies present these relationships through statistical coefficients or technical model outputs, which are not always easy for planners, designers, or community audiences to interpret (Kong et al., 2023; Khan et al., 2024). This study therefore develops a visual scenario tool that estimates how predicted pedestrian crash density changes when land use, POIs, and commuting patterns are adjusted. The purpose is not to predict every crash, but to help identify where future land-use change may increase pedestrian-vehicle exposure and where safety design should be considered early.

Conference theme
This study aligns with the ARSC 2026 theme “From Evidence to Action: Shaping a Brighter Future.” It translates empirical pedestrian crash evidence from Auckland into a visual planning tool through GAN-based scenario simulation. By showing how land use and POI adjustments are associated with predicted pedestrian crash density, the framework helps planners and road safety practitioners evaluate design interventions before implementation, bridging spatial analysis and evidence-based decision-making for safer pedestrian environments.

Method
The study focuses on Auckland’s central urban area and uses 504 Statistical Area 2 (SA2) census units as spatial units. Three sets of input maps were prepared: land use maps, including public open space, residential areas, and commuter-attracting areas; POI maps, including education-related, transport, and commercial facilities; and commuting-distance maps, including trips within, into, and out of each area. Land use and POI data were obtained from LINZ open data, and commuting data were obtained from the 2018–2023 New Zealand Household Travel Survey. The output map represents pedestrian crash density, based on 2,870 pedestrian-versus-vehicle crashes recorded in the Crash Analysis System (CAS) from 2016 to 2024. A higher output value indicates higher observed crash density in the training data or higher predicted crash density in the scenario results. The analysis therefore estimates area-level crash density, not the probability that an individual pedestrian will be injured.

The modelling framework uses Pix2pixHD, a type of GAN designed to translate one image into another. In this study, the model learns how maps of urban activity relate to maps of pedestrian crash density. Five models were trained to

examine direct and indirect relationships: land use → crash, POI → crash, land use → commuting distance, POI → commuting distance, and commuting distance → crash. The indirect models test whether commuting distance helps explain the relationship between urban activity and crash density.

Each input map contains three related variables represented through red, green, and blue colour channels. For example, the POI map combines education-related, transport-related, and commercial POIs as three separate layers. The images were divided into 512 × 512 pixel tiles at 10 m resolution, with 80% used for training and 20% for testing. Model performance was checked through visual comparison and standard image-error measures. Scenario tests then increased or decreased selected land-use and POI layers from 15% to 60%.

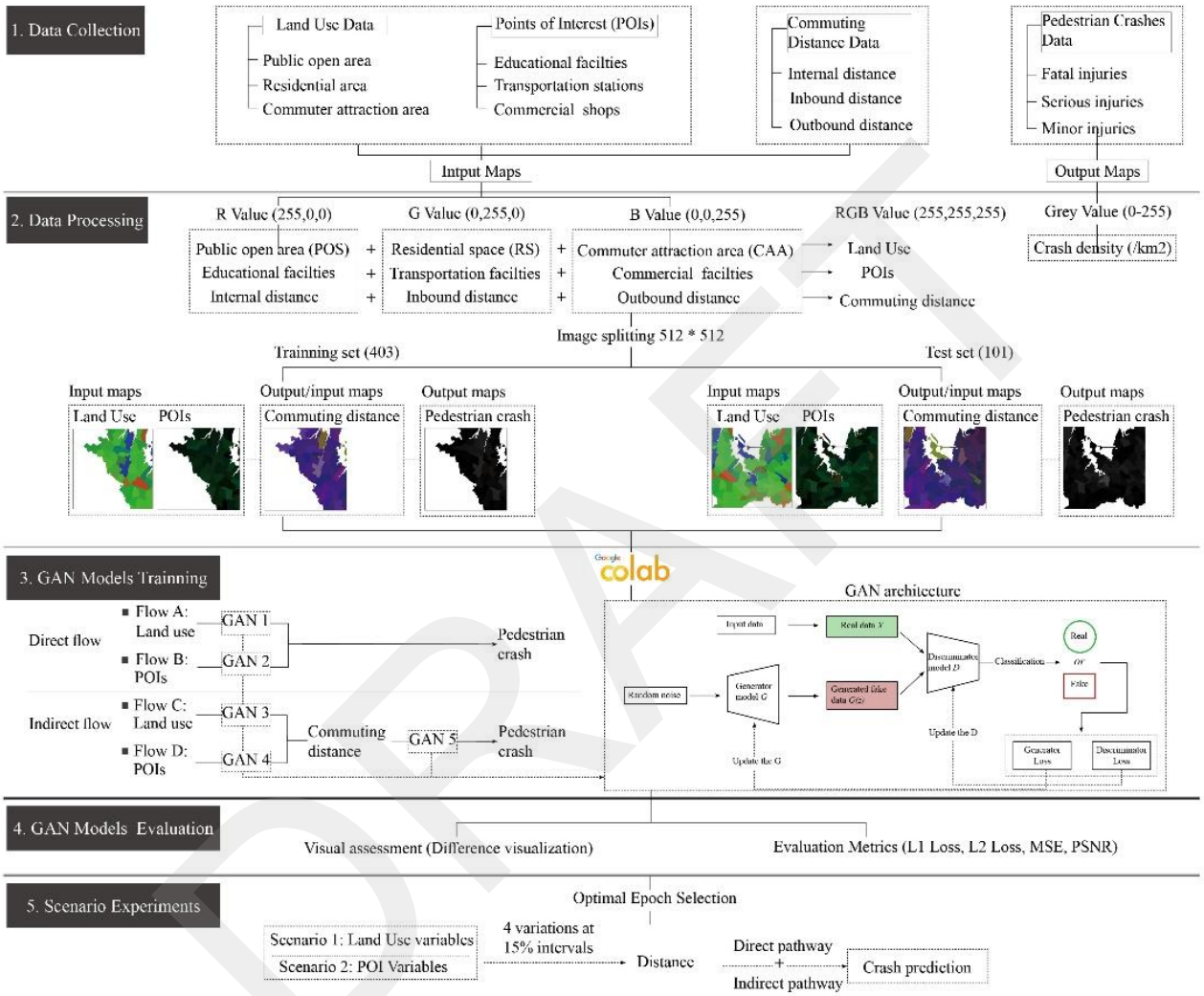

Figure 1. Research framework
Source: Author

Findings

The main findings are summarised in Table 1.

Benefits to road safety

The study offers three benefits for road safety practice. First, it provides an accessible visual method for identifying areas where land-use change may increase pedestrian-vehicle interaction. Instead of presenting only model coefficients, the framework produces maps that show where predicted crash density changes under different scenarios. Second, it highlights that concentrating several pedestrian-generating uses in the same sub-centre may be associated with disproportionate increases in predicted crash density, especially where infrastructure has not been upgraded at the same pace. Third, it supports earlier safety assessment in planning, so that pedestrian crossings, speed management, and street design can be considered before new activity is built.

Implications for policy

These findings support several practical recommendations. In CBD areas, the scenario results suggest that public open space may be associated with lower predicted crash density, although this should be interpreted alongside vehicle access

and conflict locations. In sub-centres, planning should pay particular attention to the combined location of education facilities, commercial activity, and transport stops. The GAN-based scenario simulation framework enables planners to identify possible risk thresholds and evaluate the safety implications of proposed land-use and POI changes before implementation.

Table 1. Summary of findings

Area	Scenario factor	Plain-language finding	Largest predicted change
CBD	Public open space	More public open space was associated with lower predicted crash density. This may partly reflect fewer vehicle-pedestrian conflict points in open-space areas.	-14.7%
CBD	Education-related POIs	More education-related POIs were associated with a small increase in predicted crash density.	+4.4%
Sub-centres	Land-use mix	Changing one land-use layer alone had limited effect, but combined high levels of commuter-attracting area, public open space, and residential area were associated with higher predicted crash density.	+15.4%
Sub-centres	Education, commercial, and transport POIs	When education-related, commercial, and transport POIs were all high, predicted crash density increased sharply.	+80.4%
Residential areas	Land use	Some extreme combinations were associated with threshold-like increases in predicted crash density.	+35.5%
Residential areas	POIs	Predicted crash density followed a non-linear pattern, with risk rising more sharply after some density levels were reached.	+17.8%
All areas	Direct and indirect pathways	Land use and POI maps were more strongly associated with predicted crash density than the indirect pathway through commuting distance.	About 2x stronger

Limitations

This study has two main limitations. First, consistent pedestrian and vehicle volume data were not available for all 504 SA2 units, so the analysis cannot directly measure pedestrian-vehicle exposure. Second, the scenario tests estimate area-level predicted crash density from simplified land-use and POI changes, but real development would also change traffic volume, speed, infrastructure, parking access, and pedestrian behaviour. The results should therefore be used as an exploratory screening tool rather than as proof of causal effects.

Conclusions

This study develops a GAN-based spatial prediction framework to examine the associations between land use, POIs, and pedestrian crash risks across three urban typologies in Auckland. Through scenario simulations with systematic variable adjustments, the framework captures complex nonlinear interactions that traditional regression models struggle to address. The results demonstrate that the built environment shapes pedestrian safety through both direct and indirect pathways, with context-dependent threshold and amplification effects across CBD, sub-centre, and residential areas. Future work will integrate a Genetic Algorithm (GA) with the GAN framework to optimise POI layouts at the street level, balancing crash risk minimisation with pedestrian accessibility.

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Extended Abstract

Best practice principles for driving offender intervention programs

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Abstract
Risky driver behaviour is a major concern globally due to the potential to cause injury or death. Evidence-based behavioural interventions are one means of addressing the behaviours of persistent driving offenders. A review of the published international literature was undertaken to identify the evidence-based principles underpinning effective offender intervention programs. Drawing on evidence of the characteristics of successful behaviour change interventions ten key principles relating to program design and delivery were identified. Interventions based on these principles can be expected to have the greatest likelihood of effective behaviour change.

Introduction
Risky driver behaviour is a major concern globally due to the potential to cause injury or death. The traditional approach to manage driver behaviour is through the enforcement of traffic laws, the penalties for which are intended to encourage compliance (i.e., general deterrence) or deter offenders from repeating the behaviour (i.e., specific deterrence). While a deterrence-based approach might be effective for most drivers, those who repeatedly offend despite the experience of legal or administrative sanctions may require some other approach. Punitive sanctions alone do not address the underlying causes of offending behaviour; evidence-based intervention programs that address these causes are needed to redress the behaviour of some offenders.

Conference theme
To reduce the threat to road safety posed by persistent offenders, well-designed behavioural interventions are needed. This paper provides the latest *evidence* describing the characteristics of effective interventions for driving offenders providing a sound theoretical basis for the development of *future* interventions.

Method
The characteristics of effective behavioural interventions for driving offenders were identified through a review of the international literature. A systematic approach was used to identify relevant literature, including reviews, evaluations, and other relevant evidence published since 2000. Evidence from other relevant fields (e.g., offender rehabilitation, drug and alcohol treatment, etc.) was also included.

Findings
Based on a review of the literature, key principles underpinning effective driver behaviour change interventions were identified. These are described briefly below.

Principle 1. Driver interventions should have a sound theoretical basis in terms of what causes behaviour and the approach or mechanisms through which behaviour is changed.
Any form of behavioural intervention should be based on a theory that explains both the determinants of behaviour and identifies the mechanisms through which behaviour change can be achieved (Casey et al., 2013). One of the more consistent findings in the literature is that interventions that are developed based on sound theoretical principles demonstrate greater effectiveness and better outcomes than those that are not (Pooley, 2020). While there are many relevant theories of behaviour change (e.g., Theory of Planned Behaviour, the Health Belief Model, Protective Motivation Theory, the Transtheoretical Model of Change, and Social Learning Theory) it is acknowledged that no single theory is superior. The COM-B is an example of a behavioural system that identifies the overarching mechanisms of behaviour (Capability, Opportunity, and Motivation) derived from a synthesis of existing theory (Michie et al., 2011).

Principle 2. Programs should form part of a multi-modal approach.
Behavioural interventions for drivers should exist alongside a broader multi-modal approach that incorporates elements of therapy (e.g., identifying triggers, planning, modelling), education, and administrative measures. Evidence shows that different types of driving behaviour respond to different intervention approaches (Tirla et al., 2024). The integration of an intervention with other existing countermeasures is also an important consideration.

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Principle 3. The primary modality through which behaviour change should be achieved is through recognised therapeutic approaches incorporating cognitive-behavioural elements and techniques to enhance participant motivation.

Program delivery is potentially the most important element of a behavioural intervention, as it is the way the intervention is conducted and delivered that will ultimately determine the nature and extent of change in behaviour. Programs that adopt a therapeutic approach consistently demonstrate effective outcomes due to the adoption of strategies that have demonstrated efficacy in helping people change behaviour, particularly through the use of cognitive-behavioural strategies including identifying triggers and barriers, developing strategies and problem solving skills, motivational enhancement, challenging maladaptive beliefs and thinking styles (Bukasa et al., 2008). Therapeutic approaches also address the psychological underpinnings of behaviour as described by behaviour change theories such as the COM-B.

Principle 4. Attendance at a program should be mandatory and, where applicable, a condition of regaining a licence.

While successful behaviour change requires the individual to recognise the existence of a problem and to be motivated to change their behaviour, there is evidence that mandatory drink driver programs can be effective and offenders mandated to treatment tend to remain in treatment longer, leading to better outcomes (Wallace, 2011).

Principle 5. Program intensity should match the level of risk of offenders.

The intensity of the intervention should match the level of risk. This is one of the core tenets of the risk-needs-responsivity model of offender rehabilitation. Those at high risk of reoffending who attend low-intensity interventions are unlikely to change behaviour but those of low risk attending high intensity interventions can have a negative effect and increase risk (Pooley, 2020). Programs that match participants to the appropriate program intensity have generally been found to be more effective than those that do not (Day & Howells, 2002).

Principle 6. All offenders, including first time offenders, should undergo an assessment of risk that includes assessment of substance use disorders and other factors that may impact successful program completion.

Driving behaviours, as with other behaviours, are complex and multifaceted. As per Principle 5, the success of an intervention lies with matching intensity with level of risk. As such, it is important to undertake some form of assessment to determine suitability (level of risk).

Another aspect of assessment and program suitability lies in the separation of interventions for different driving offences. Different types of driving behaviours are associated with different types of causal factors. For example, risk factors for drink driving include alcohol abuse or dependence, mood disorders, antisocial behaviour, positive attitudes towards drink driving, while those for reckless or dangerous driving include sensation seeking, risk taking, general deviant ideation, peer pressure, and aggression. As such, targeting factors associated with the identified problem is integral for successful rehabilitation (Casey et al., 2013).

Principle 7. Program attendance should commence as close to the initial offence as possible.

It is generally believed that driver interventions should occur as close to the initial offence as possible (Bukasa et al., 2008). In the context of driving under the influence of a substance, early intervention may yield better outcomes, particularly where the aetiology of the offence indicates psychological antecedents such as dependence (e.g., alcoholism) or abuse. Earlier intervention will allow sufficient time to address complex behaviours that may take a long time to achieve the necessary behaviour change (Wallace, 2011).

Principle 8. Driving interventions should not replace other penalties.

Evidence from the literature indicates that where diversion to an intervention accompanies a reduction in penalty, the effectiveness of the intervention is reduced. Furthermore, the evidence suggests it is not meaningful to dispense with punitive measures in favour of rehabilitation (SUPREME, 2007). Rather than replace or modify penalties, driver rehabilitation programs should be an integrated part of a comprehensive system of countermeasures, including legal penalties and vehicle technologies (e.g., alcohol interlocks; Bukasa et al., 2008).

Principle 9. Programs should be delivered by trained personnel with the relevant experience and qualifications for working in behavioural interventions.

Personnel responsible for the delivery of the intervention should have skills commensurate with the nature of the program. Presenters should receive appropriate training in the therapeutic modalities of the program and have

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qualifications from a relevant field (e.g., social sciences, counselling, adult education; Day & Howells, 2002). An understanding of the issues associated with a variety of risky driving behaviours and some knowledge of road safety is desirable.

Principle 10. Programs should be evaluated, including process and outcomes. Ideally, data collection should be built in as part of program delivery.

Program evaluation plays a key role in monitoring the effectiveness of the program and also ensuring programs are delivered as intended. Pooley (2020) suggests that evaluations are important in the development and delivery of programs as they provide both measures of effectiveness (i.e., what works) and evidence to refine the existing program and support the development of future programs. In their systematic review of young offender programs, Pooley (2020) found that programs that included mechanisms for evaluation were associated with better outcomes than programs that did not.

Benefits to road safety

Changing the behaviours of driving offenders improves safety by reducing those behaviours that are known to result in injury or death. Behavioural interventions based on these evidence-based principles have the greatest likelihood of success.

Implications for policy and/or practice

Identifying the best practice principles underlying effective behavioural intervention programs is important for designing and implementing programs with the greatest efficacy. It also supports evidence of the effectiveness of behavioural interventions and helps ensure resources are utilised in the most efficient and effective manner.

Conclusions

The adoption of evidence-based behavioural interventions is an important tool to improve the behaviour of drivers who persistently engage in unsafe driving. Interventions based on the principles described above will have the greatest likelihood of reducing unsafe driving behaviours, leading to safer outcomes for all road users.

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Do Indian Drivers Share a Common Understanding of Road Rules?

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Abstract
Road crashes in India claim over 19 lives every hour, with human error implicated in over 92% of cases. While interventions have targeted visible violations such as speeding and helmet non-use, a more foundational problem remains unexamined- whether Indian road users share a consistent understanding of road rules and fault attribution. This pilot study used 18 conflict scenarios, recreated using BeamNG simulation software and administered across three languages to 107 participants, to empirically measure disagreement in fault attribution. Shannon entropy analysis revealed near-uniform disagreement across 16 of 18 scenarios, with 10 scenarios showing normalised entropy above 0.86- indicating an almost total absence of consensus. Only 2 scenarios showed moderate agreement. These findings provide the first empirical evidence of a fundamental gap in shared road rule understanding among Indian road users, offering an empirical basis for identifying the specific road rule concepts that require targeted interventions, enabling evidence-informed communication, driver training, licensing reform, and road safety policy.

Introduction
India reported 1,72,890 death and 4,62,825 injuries in 2023 (MoRTH, 2025). With human error accounting for around 92% of these accidents, driver behaviour has rightly been placed at the centre of road safety interventions, focusing on measurable violations such as speeding, helmet use, and drunk driving. These efforts, while necessary, have addressed only the most visible dimensions of the problem. A more foundational issue has gone unexamined- when an everyday road interaction escalates into a crash, is there a shared understanding among Indian drivers of who bears responsibility. Widely circulated dashcam footage on social media routinely shows drivers in identical scenarios arriving at entirely opposing conclusions about fault, potentially pointing to a systemic inconsistency in basic road rule comprehension, that existing interventions have neither recognised nor measured.

For decades, LMICs like India have looked to high-income countries for road safety models- adopting Graduated Driver Licensing, standardised training, and tools like the Driver Behaviour Questionnaire (Assi, 2018; Gupta et al., 2021; Jomnonkwao et al., 2022). These adaptations represent genuine progress, yet they have carried an implicit assumption that may not hold in the Indian context: that the foundational layer of driver understanding is already in place. Elvik (2022) demonstrated that road safety measures produce two interacting effects- an engineering effect and a behavioural adaptation effect. In HICs, this interaction is predictable because a consistent baseline understanding exists, allowing research to advance to higher-order functions such as hazard perception, attitude, and motivation (Barragán et al., 2021; Harms, 2023; Ventsislavova et al., 2018; Zhang et al., 2026). A systematic review of driver education interventions in LMICs found that while structural reforms such as GDL and standardised curricula are necessary, their effectiveness is contingent on contextual relevance- interventions designed without accounting for the local driving environment, rule comprehension gaps, and road culture consistently underperform (Rajkumar et al., 2025). The context-specific gap this systematic review identified- and which India most acutely exemplifies- is precisely the inconsistency in foundational road rule understanding that the present study sets out to measure.

Conference theme
This study aims to empirically establish whether a consistent understanding of road rules and fault attribution exists among road users in India, using conflicting crash scenarios as a diagnostic tool. By measuring the degree of disagreement in how drivers interpret and assign responsibility in identical road situations, the study generates foundational evidence of a gap that has thus far been assumed but never measured. This evidence is intended to directly inform action - providing the empirical basis for targeted reform of driver training curricula, licensing assessments, and road safety policy in India, shifting the focus from awareness of isolated rules to the development of a shared, consistent understanding of road behaviour that is a prerequisite for any effective safety intervention.

Method
This pilot study tested the validity of 18 conflicting crash video scenarios developed from real-world footage sourced from social media platforms and commonly reported crash typologies across India. Each scenario was recreated using BeamNG, a high-fidelity vehicle simulation tool, ensuring controlled and consistent visual presentation. Scenarios were classified across seven road rule domains- right-of-way, lane discipline, speed rules, signals and signs, gap acceptance,

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road hierarchy, and parking/stopping- with each scenario representing one or more domains to reflect the overlapping nature of real-world crash conflicts.

Data was collected during a university open day in a dedicated room. Participants, 18 years or older, accessed the questionnaire via QR code in three languages- English, Hindi, and Kannada- completed demographic questions, then viewed each scenario on a shared projector screen and recorded their individual fault attribution response on personal devices. Each session closed with a brief group discussion for validation of scenario clarity.
Each simulated driving scenario was developed to represent a specific Rules of the Road interaction, including situations where the governing rule is well established, poorly understood, absent, or where multiple rules interact and their application is uncertain. Participants were asked to indicate who they believed was at fault, not to assess legal correctness, but to capture how they interpreted and applied these road rules when evaluating the same traffic situation.
To quantify the degree of disagreement across responses, Shannon entropy was applied to each scenario's response distribution. Entropy measures how spread or concentrated responses are- a low entropy score indicates most respondents attributed fault to the same party, reflecting shared understanding, while high entropy indicates responses were widely distributed across options, reflecting inconsistent or absent shared understanding. This made entropy the appropriate tool to empirically test whether consensus in fault attribution exists across the sample.

Results

The study captured 107 responses with a mean age of 22.8 years, predominantly young adults (18-25), 55% female, and 56% students. Notably, 58% had received no formal driver training- among those who had, driving school was the most common method followed by family. This is further reflected in the training-experience split, where untrained respondents outnumbered trained ones in every experience group except those with more than 10 years of driving, suggesting that formal training in this sample is the exception rather than the norm for newer drivers. The license and experience heatmap reinforces this concern- 28 respondents reported no license and no driving experience, yet 24 with no license reported active driving experience of up to five years, indicating a substantial proportion driving without formal authorization (see Figure 1). For daily commuting, bus and walking/cycling were the most frequently used modes (mean score 1.94), while bike/scooter usage was high and variable, consistent with India's two-wheeler dominant road culture (see Figure 1).

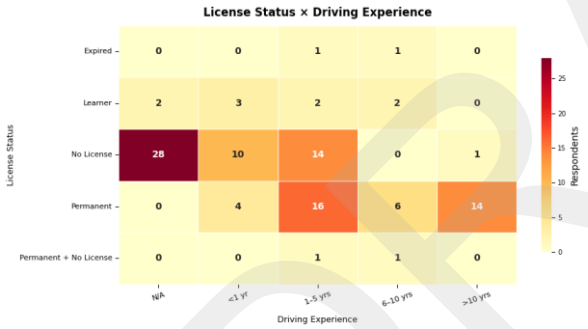

Figure 1. (a) Heatmap of Respondent Distribution by License Status and Driving Experience

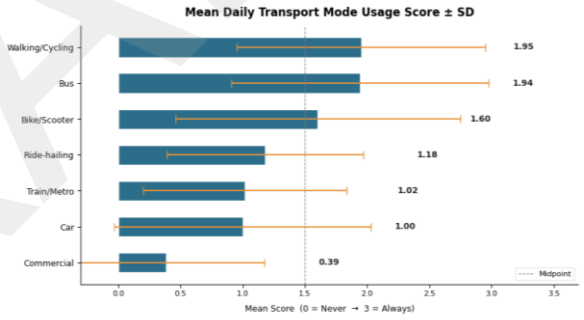

Figure 1. (b) Ranked Bar Chart of Mean Daily Transport Mode Usage Score with Standard Deviation

The Shannon entropy analysis across all 18 scenarios reveals a consistently high degree of disagreement in fault attribution among respondents, with the majority of scenarios showing very high to high entropy. Ten scenarios showed normalised entropy above 0.86- indicating near-total absence of consensus (7, 18, 14, 10, 6, 5, 4, 2, 16, 15)- a further six fell in the high range (0.67-0.83) with no dominant answer (9, 11, 8, 12, 17, 3), and only two scenarios (1 and 13) reached moderate entropy (0.54-0.55), representing the only instances of partial shared understanding. This pattern of near-uniformly high entropy directly and empirically confirms the study's core premise- that there is no consistent shared understanding of road rules and fault attribution among Indian road users.

In a population with a common baseline understanding, you would expect entropy to cluster toward the lower end for most scenarios, with high entropy only in genuinely ambiguous edge cases. The inverse observed here- where high entropy is the norm- is itself the evidence. Scenarios 1 and 13 warrant further examination as anchors of existing understanding, while scenarios 15, 16, 2, 4, and 5 represent the most critical targets for driver education intervention.

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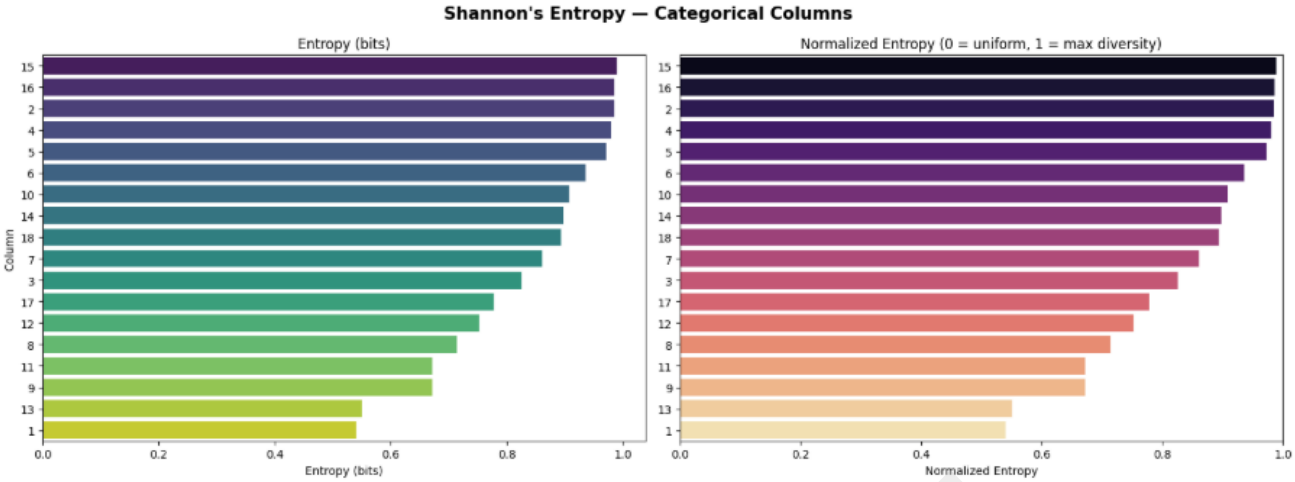

Figure 3. Bar Chart of Shannon's Entropy Scores Across Conflict Scenarios

Conclusions

This pilot study provides the first empirical evidence that a consistent shared understanding of road rules and fault attribution does not exist among Indian road users. Across 18 conflict scenarios, Shannon entropy analysis revealed near-uniform disagreement in 16 of 18 cases, confirming the study's core premise. The methodology - using BeamNG-recreated video scenarios delivered across three languages - proved viable and effective as a measurement instrument. The sample, while young and student-dominated, reflects a population actively using Indian roads largely without formal training, lending ecological validity to the findings. The findings also provide an empirical basis for identifying the specific road rule concepts where shared understanding is weakest, enabling targeted communication, driver education, licensing reform, and other evidence-informed road safety interventions. The results justify scaling this study to a larger and more diverse population.

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Transfer of hazard management to speed management, and vice versa

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Abstract
Young novice drivers possess underdeveloped Hazard Management (HM) and Speed Management (SM) skills, contributing to their overrepresentation in road-related trauma. While isolated training effectively enhances targeted skills, few studies have investigated their transferability between these domains. This study examined skill transfer in a simulated road environment. Ninety young novice drivers were randomly assigned to one of five experimental groups: Control, Implicit Training, SM Feedback, HM Training, and HM Training groups. Immediate post-training assessment revealed skill acquisition in the targeted skills, but no skill transfer. These findings expose the critical limitations of isolated training and underscore strict boundaries in skill transfer. Therefore, road safety authorities and training designers should address these limitations by developing training approaches that cultivate both safety skills concurrently. Such training has the potential to address this young novice driver problem.

Introduction
Hazard management (HM) and *speed management* (SM) skills are key critical skills for drivers. Deficiencies in the ability to anticipate hazardous events and select an appropriate speed directly contribute to road crash involvement, particularly among young novice drivers (Clarke et al., 2006; Foss et al.). Young novice drivers are involved in nearly a quarter of all fatal road crashes in New South Wales (TfNSW, 2025).

Training is an effective method to accelerate the acquisition of these proficiencies (Deery, 1999). A recent systematic review indicates no shortage of independent HM and SM training (Ratchaneepun et al., 2026). While the respective training enhanced their targeted skills (HM with commentary training and SM with feedback about speed choice; McDonald et al., 2015; Molloy et al., 2023), the isolated approaches resulted in limited transfer between these skills.

Skill transfer between distinct domains, 'far transfer', remains a complex phenomenon. According to Barnett and Ceci's taxonomy, transfer operates across nine dimensions broadly categorised into 'Content' (what is transferred) and 'Context' (when and where generalisation occurs) (Barnett and Ceci, 2002). In automotive safety, managing vehicle speed and responding to on-road hazards (e.g., a pedestrian emerging behind a bus) share core 'Content' demands, as both require immediate speed reduction to avert collision. However, the 'Contextual' dimensions governing when and where drivers should deploy these adjustments are less predictable, complicating effective skill transfer.

This leaves a critical gap in the development of these important safety skills. Heightened hazard management skills may paradoxically prompt higher driving speeds; as drivers' perceived risk decreases, they adjust their behaviour upward to match their target risk level and maximise travel efficiency (Wilde, 1982). With one skill underdeveloped, young novice drivers are still at risk of being involved in car crashes. Therefore, this study aims to investigate the skill transfer between HM and SM skills. These two skills were evaluated using a 'far-transfer' scenario (fundamentally different from the training session), and within a 60 km/h speed zone. These specific environmental conditions were used since they have been shown to reliably differentiate varying levels of HM and SM proficiency (McDonald et al., 2015; Molloy et al., 2023). Informed by these identified gaps in the literature, the present study addresses three primary research questions.

1. What is the impact of HM training when evaluated in a far-transfer scenario?
2. What is the impact of SM feedback on young novice drivers' speeding behaviour in 60 km/h speed zones?
3. Do HM skills transfer to the SM situation, and vice versa?

Conference theme
Current *evidence* reveals a lack of skill transfer between HM and SM skills with young novice drivers. To translate this finding into *action*, training designers and road safety authorities should urgently address this gap by overhauling

training paradigms. Consequently, the successful creation of a training programme that successfully integrates these two important safety skills has the real potential to reduce the crash risk with this vulnerable group.

Method

Ninety young novice drivers aged 18–25 (M = 19.60, SD = 1.59), all holding a provisional licence, participated in the research. Recruited from the University of New South Wales (UNSW), all participants provided informed consent. The protocol was approved by the UNSW Human Research Ethics Advisory Panel (HC230245).

A 2 x 5 mixed factorial design was utilised. The within-subjects factor, Time, contained two levels (baseline & immediate post-training). The between-subjects factor, Intervention comprising five levels: (1) *Control* (no training); (2) *Implicit Training* (hazard exposure without explicit instruction); (3) *SM Feedback* (hazard exposure augmented with holistic feedback on personal speeding behavior, safety implications, and financial penalties); (4) *HM Training* (commentary training without feedback); and (5) *HM Training with HM Feedback* (commentary training with feedback on hazard perception, projection, and evasive action).

Driving performance was captured using a low-fidelity driving simulator running UC-win/Road software. The simulated environment included a 5-km practice route and 21-km experimental routes. The experimental routes contained nine strategically embedded hazardous events, categorised as Behavioural Prediction (BP), Environmental Prediction (EP), and Divided Focus and Attention (DF) hazards (Ratchaneepun et al., 2026), which were systematically distributed across three (50, 60, & 80 km/h) speed zones. During the session, participants completed a demographic questionnaire, followed by a 5-km practice drive, a baseline assessment, an intervention block, and an immediate post-training assessment.

Two primary dependent variables featured: HM performance (percentage of travelled distance before braking) and SM performance (percentage of time exceeding the speed limit). Furthermore, only performance with the EP hazard in the 60km/h zone was analysed. Statistical analyses, namely a series of ANOVAs were conducted in IBM SPSS version 30. Bonferroni correction was applied to control for familywise Type I error rates, with alpha adjusted from .05 to .025. Only statistically significant results are reported.

Findings

To illustrate the efficacy of training, findings on EP hazards in far-transfer scenarios are presented. Preliminary analyses confirmed that all ANOVA assumptions were met. A mixed-model ANOVA revealed significant main effects for Group, and a significant Time by Group interaction. Since the Time by Group interaction encompasses the main effect, only this interaction was analysed. The ANOVA failed to reveal a statistically significant difference between groups at baseline. However, at the immediate post-training assessment, a significant simple main effect for Group was revealed, F (4,85) = 5.65, p < .001, ηp^2 = .21. Bonferroni-adjusted pairwise comparisons revealed during the far-transfer EP scenario, the 'HM Training with HM Feedback' cohort exhibited a significantly shorter braking response distance compared to the following three groups: 'Control' (p < .001), 'Implicit Training' (p = .003), and 'SM Feedback' (p < .001) (see Figure 1(a)).

For SM performance, only a Time by Group interaction was revealed. At baseline, the test failed to reveal a statistically significant difference between groups. Immediately post-training, a significant simple main effect for Group was observed, F (4,85) = 5.34, p < .001, ηp^2 = .20. Bonferroni-corrected comparisons revealed that the 'SM Feedback' group spent a significantly lower percentage of time exceeding the speed limit relative to the 'Control' (p = .004), Implicit Training (p < .001), 'HM Training' (p = .002), and 'HM Training with HM Feedback' (p = .005) groups (see Figure 1(b)).

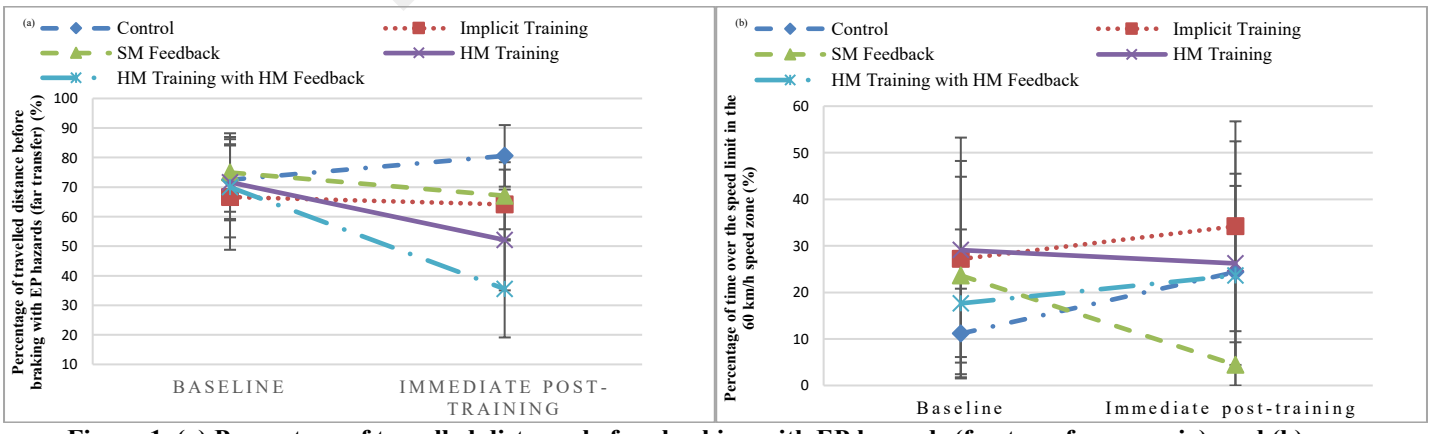

Figure 1. (a) Percentage of travelled distance before braking with EP hazards (far-transfer scenario), and (b) Percentage of time over the speed limit in the 60 km/h speed zone.

These findings confirm the target-specific efficacy of both training interventions. HM Training, augmented with comprehensive feedback on perception, projection, and action, significantly enhanced novice drivers' HM skills when encountering hidden (EP) hazards, in a far-transfer scenario. Similarly, targeted SM feedback successfully attenuated speeding behaviours within the 60 km/h speed zone. While these findings align with previous research concerning both HM (McKenna et al., 2006) and SM (Molloy et al., 2023) training, they highlight strict boundaries in skill generalisation. Specifically, improving a driver's HM yields no collateral benefit to their SM, and vice versa.

Benefits to road safety

These findings deliver critical evidence for training designers and road safety authorities by highlighting the limitations of isolated skill development. Translating this evidence into action necessitates a paradigm shift toward integrated training approaches that concurrently cultivate both HM and SM proficiencies. Deploying such a training model will better equip young novice drivers for the complexities of real-world driving, directly reducing their overrepresentation in road trauma and accelerating progress toward our 2030 safety targets.

Implications for policy and/or practice

These findings have direct implications for the current Graduated Licensing Scheme (GLS). At present, licensing milestones rely heavily on isolated assessments, such as the Hazard Perception Test (HPT) and Driver Knowledge Test (DKT), which are not sufficient to prevent young novice drivers from being involved in road crashes. Additional training that targets both hazard management and speed management should be considered a prerequisite before candidates undertake such tests. The findings in this study demonstrate a lack of skill transfer between these two key safety skills. To meaningfully prevent young novice drivers from being overrepresented in road crashes and to meet the 2030 safety targets, licensing authorities and training designers should design training interventions informed by these results to improve HM and SM skills concurrently.

Conclusions

Target-specific training for both HM and SM is plentiful. Such training, as demonstrated in the current study, illustrates that these methods effectively equip young novice drivers to manage hidden (EP) hazards and improve their speed management behaviour. Crucially, however, no transfer between such skills results. Improved HM skills do not translate into better SM, and vice versa. These findings provide a critical evidence base for policymakers and training designers to develop comprehensive training programmes within the driver licensure system. Future research should pivot toward developing an integrated intervention, specifically designed to cultivate HM and SM proficiencies simultaneously.

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Tracking public perceptions for a brighter safer future

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Abstract
Effective road safety management relies on robust evidence, strong leadership, and the application of proven interventions. Tracking public perceptions provides an important evidence source for understanding community attitudes towards safety risks, interventions and system change. NZ Transport Agency (NZTA) undertakes regular road safety surveys called the Road User Safety Monitor (RUSM), which tracks safety behaviours and how New Zealanders view and respond to road safety issues and initiatives. This evidence has become increasingly important as media and social media can amplify highly visible views that are not always representative of broader public attitudes. By drawing on consistent, longitudinal data, the survey helps identify genuine trends, provide meaningful insights and separate short-term reactions from longer-term shifts in sentiment. The survey and insights equip us with a robust, evidence-based foundation for improving road safety outcomes.

Introduction
The recently published *Austroads Best Practice Guidance in Road Safety Management and Leadership Proven Initiatives and Case Study Examples* outlines requirements for effective road safety management: a comprehensive and evidence-based approach that incorporates the latest research, best practices and leadership.

One of the 10 proven initiatives is fostering greater community acceptance of road safety, making a robust understanding of public attitudes essential. In New Zealand, public attitudes surveys have been undertaken by the Ministry of Transport and NZTA for more than 20 years. The first significant survey was conducted in 2004, with the latest Road User Safety Monitor (RUSM) annual report published in December 2025. A key feature of the survey is that both the report and underlying data are publicly available, promoting transparency and enabling transport professionals, decision makers, communities, researchers and industry partners to better understand public attitudes toward road safety.

Improving road safety requires ongoing change to both the transport system and road user behaviour. The survey plays a key role in understanding how people are responding to road safety initiatives and broader system changes. It also helps identify emerging trends, assess changing levels of support, and highlight where additional communication or engagement may be required. An ongoing challenge is balancing the need for long-term consistency in survey questions with the flexibility to respond to emerging issues and policy priorities.

Conference theme
The RUSM provides robust, evidence-based insights into how people perceive key road safety issues—from speed, impairment, safety infrastructure, and enforcement approaches. By monitoring these views, the survey helps identify shifting trends and insights. These insights directly support the ARSC2026 theme *From Evidence to Action: Shaping a Brighter Future* by providing real-world evidence that can better inform how to approach various road safety initiatives e.g. road safety education campaigns. In doing so, the survey provides a critical connection of understanding public perspectives and improving road safety outcomes.

Method
The survey methodology has evolved over time, moving from in-person face to face interviews to computer assisted telephone interviewing (CATI) to the current methodology of an online survey.

- Up to 2016: The previous survey was conducted using face-to-face interviews of 35 minutes duration.
- In 2020, due to COVID-19 restrictions, a new survey was conducted using CATI. The survey continued to be conducted via CATI in 2021 and 2022. Each survey was conducted annually, with either one or two streams, and with a sample of n = 1,665 per stream.
- In 2022, a parallel survey to the CATI fieldwork was also conducted using online interviewing. The results were used to understand the potential implications of transitioning the survey from CATI to online surveying.

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In 2024, the survey was transitioned to a continuous, online survey with an annual sample of n = 6,660. The new approach provides the following benefits:

- A larger annual sample gives more robust comparisons for trends year on year than can be achieved via CATI.
- Quarterly fieldwork allows more timely reporting, including responses to advertising campaigns and policy changes.
- Continuous fieldwork allows seasonal changes to be reflected in the data.

Results

In the latest RUSM 2025 annual report are key insights and a detailed summary from July 2024 – June 2025 across 9 themes: general attitudes to enforcement, speed and speed enforcement, alcohol-impaired driving and enforcement, drug-impaired driving and enforcement, seat belts, fatigue, driver distraction, vehicle safety and safety of travelling.

The RUSM 2025 annual report outlines several trends in New Zealanders' attitudes:

- Enforcement Support: 73% of New Zealanders support a greater police presence on the roads, and 55% believe more effort should be put into catching those breaking road safety laws.
- Safety Perceptions: While 90% feel safe as drivers or passengers in urban areas, only 40% feel safe walking or cycling on rural roads.
- Seat belt use among adults: Twelve percent of New Zealanders admit to not wearing a seatbelt in the past month while travelling in a vehicle with one available.
- Attitudes towards speed limits and safety cameras: Around seven in ten New Zealanders (73%) agree that enforcing speed limits helps reduce road deaths. Similarly, seven in ten (71%) think safety cameras are effective in reducing the number of people speeding.
- Safe System Approach: There is strong public backing (79%) for the "Safe System" approach, which acknowledges that human error is inevitable and focuses on making the road system more forgiving.
- Acceptability of Road Deaths: A notable 15% of respondents still believe that more than 200 deaths per year on NZ roads is "acceptable" for the sake of mobility.

Below are two examples of the detailed summaries that are provided for each of the questions asked as part of the survey.

Agreement that: Any deaths or serious injuries to people while travelling on New Zealand's roads is unacceptable.

Four in five New Zealanders support the statement that any deaths or serious injuries while travelling on New Zealand roads is unacceptable. Only a minority of 7% oppose this statement, being more common among men aged 25 to 64.

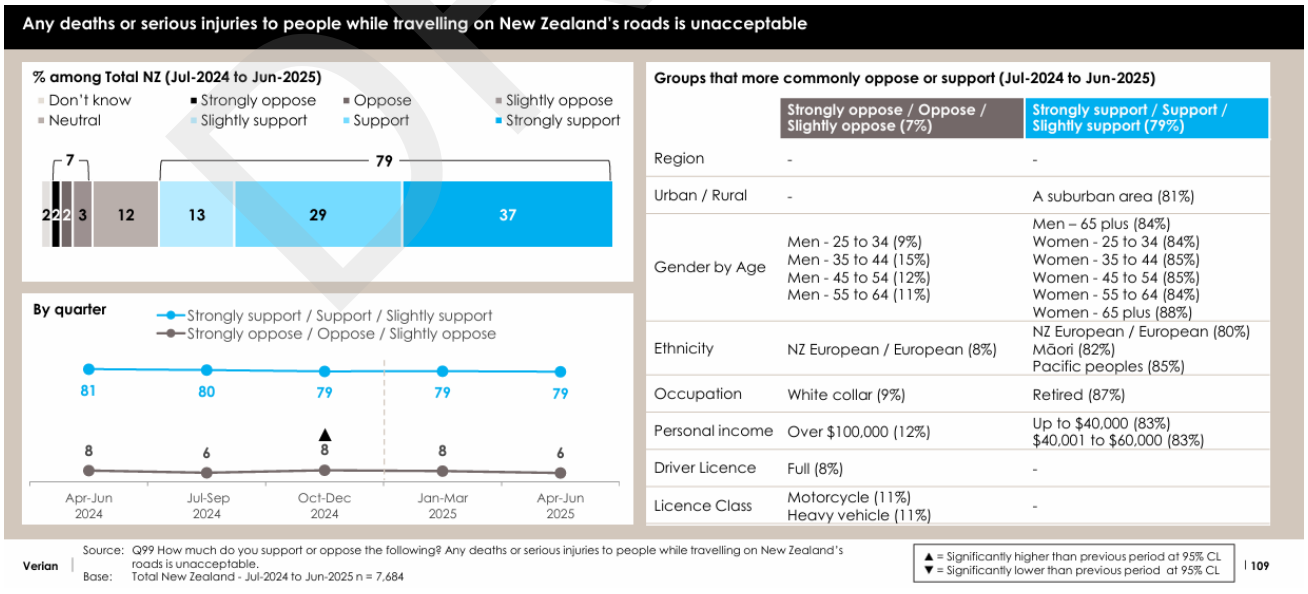

Figure 1. Detailed summary Any deaths or serious injuries to people while travelling on New Zealand's roads is unacceptable.

Source: Road User Safety Monitor - 2025 annual report page 109

DRAFT

The higher the speed you are travelling, the greater the chance of having a crash
Almost four in five (78%) understand that the higher the speed you are travelling, the greater the chance of having a crash. Only a minority of 9% disagree, being higher among men aged 35 to 64, and those with a motorcycle or heavy vehicle licence.

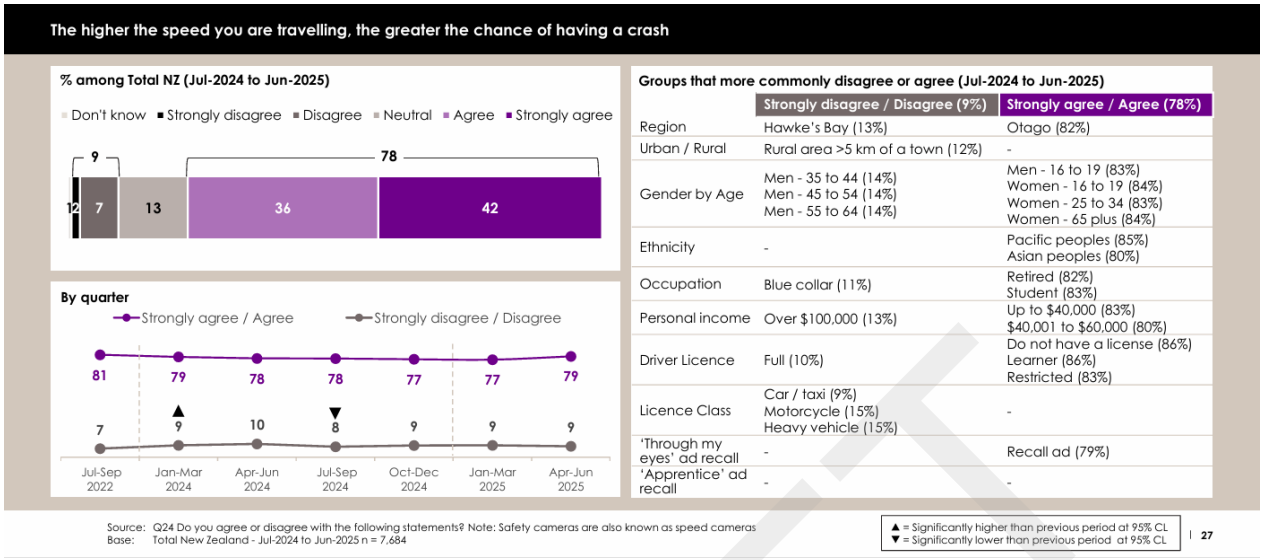

Figure 2. Detailed summary Speed and speed enforcement: The higher the speed you are travelling, the greater the chance of having a crash
Source: Road User Safety Monitor - 2025 annual report page 27

Benefits to road safety

This work directly strengthens road safety outcomes by providing robust evidence on how the public perceives key safety risks and interventions. Insights from the survey supports decision making for policymakers and practitioners by turning real-world public sentiment into actionable intelligence to deliver progress toward a safer, more equitable transport system embodying the ARSC2026 theme *From Evidence to Action: Shaping a Brighter Future*.

Implications for policy and/or practice

RUSM data has been invaluable for developing and tracking road safety education campaigns, which are designed to shift attitudes and social norms and, ultimately, reduce risky behaviours. It is also used to inform our road policing activities, the data helps show the perceived likelihood of enforcement for behaviours such as drug driving, speeding and alcohol use, as well as perceptions of crash risk and harm associated with speeding. It will also be used in the comparison of observational research on seatbelts and driver distraction mobile phone use.

Conclusions

The RUSM demonstrates the value of sustained, transparent public attitudes research as part of effective road safety management. By tracking perceptions over time, the survey provides decision makers with a clearer understanding of how New Zealanders view key safety risks, proven interventions and the wider system changes needed to reduce deaths and serious injuries.

The latest results show strong public support for core elements of a Safe System approach, while also highlighting areas where attitudes, understanding and perceived risk continue to vary. These insights help ensure road safety policy, investment, enforcement and communication are grounded in robust evidence.
As New Zealand continues to respond to emerging road safety challenges, the RUSM provides an important bridge from evidence to action. It supports timely, targeted and transparent decision making, strengthens confidence in proven interventions, and helps shape a brighter, safer future for all road users.

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Experience of drug driving: a qualitative study

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Abstract
Drug driving remains a major public health and safety issue. Drugs impair driving ability and contribute significantly to road trauma and fatalities in Australia. While alcohol-related road trauma has declined over the past two decades, deaths from crashes involving illicit drugs have increased. Alongside traditional enforcement through Victoria's Roadside Drug Testing (RDT) program, work is underway to optimise drug driving countermeasures. Achieving this requires a deeper understanding of the perceptions, experiences, and knowledge of Victorians who use drugs and drive. To address this gap, the Transport Accident Commission (TAC) commissioned Turning Point to conduct a qualitative study exploring perceptions, knowledge, and experiences of Victorian adults (18 +) who drug-drive. The study generated valuable insights for road-safety partners, highlighting opportunities to address misinformation about RDT and strengthen partnerships with the Alcohol and Other Drug (AOD) sector. These partnerships offer potential for combined enforcement and health-based approaches to reduce drug driving harm.

Background.
Despite declines in alcohol-related road trauma over the past two decades, deaths from crashes involving illicit drugs have risen by 87.4% in Australia (Bureau of Infrastructure, Transport & Regional Economics, 2021). Research conducted in Victoria found illicit and licit drugs were detected in 38.7% of injured drivers from 2013 to 2018 (DiRago et al., 2021) and 41.1% of drivers killed between 2006 and 2016 (Schumann et al., 2021). The Transport Accident Commission (TAC) reports that 25% of Victorians who use drugs admit to driving under the influence of recreational drugs (TAC, 2022). This suggests the current drug-driving countermeasures may have limited effectiveness for some drug users in Victoria, who also drive.

A MUARC (2021) study, found that of the 460 drug-driving offences detected between September 2020 and February 2021—where a roadside infringement notice and fine was issued —73.3% of fines remained unpaid at 28 days. Combined with high rates of recidivist drug driving (40%), these findings suggest that deterrence-based approaches alone may have limited effectiveness for some people who drug drive.

The TAC sought to understand the experiences, motivations, and behaviours of people who drug drive to identify and address barriers, expand knowledge, and support opportunities for behaviour change, with the aim of reducing fatal and serious injuries within this group. The objectives of the study were to:

- Gain contextual understanding of drug driving – explore drivers' perceptions and understanding of drug effects in the context of driving.
- Understand the reasons for and experiences of drug driving.
- Identify the factors that influence whether (or not) people drug drive.
- Evaluate Victorian drug driving law comprehension – assess driver understanding of current drug driving laws in Victoria.
- Understanding peoples' experiences of programs and support associated with drug driving, and exploring strategies, initiatives and policies that can be implemented to prevent drug driving and improve support.

Conference Theme
This work aligns strongly with this year's conference theme, Evidence to Action: Shaping a Brighter Future, as this qualitative study was undertaken in collaboration with frontline Alcohol and Other Drug (AOD) providers creating new opportunities to deliver innovative drug driving countermeasures. A central component of the study was the appointment of Turning Point, Australia's leading national addiction treatment, training, and research Centre. This partnership enabled meaningful engagement with key groups across the AOD sector, supporting a deeper understanding of road safety issues and, in particular, drug driving risk. Continued engagement with AOD practitioners will strengthen these connections further and help ensure that emerging evidence is effectively translated into practice.

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Project description

Limited research has explored the experiences of drug drivers, their perception of what constitutes drug driving and its associated penalties, or the more complex factors that may lead a person to drug drive. This is the first study of its kind in Australia seeking insights from those who have been detected or self- report drug driving. Understanding motivations, behaviours and barriers to behavioural change can help road safety partners consider relevant, appropriate and population-specific drug driving interventions.

This study used a qualitative approach involving (1) in-depth one-on-one interviews with people who self-report drug driving or have been detected drug driving and (2) observations of participants in the VicRoads Behaviour Change Program. (BCP). Observations of VicRoads BCP were undertaken to validate aspects of the interview data that made reference to the BCP. One hundred participants took part in the study. Ethics approval for this project was obtained from the Monash Human Research Ethics Committee prior to the commencement of participant recruitment.

Interview participants were primarily recruited through website and social media (Facebook, LinkedIn, and X) advertisements; Turning Point research projects, programs, and networks with people who use drugs; and VicRoads BCP. These channels were used to ensure the inclusion of people who have been detected drug driving, as well as those who engage in drug driving but may not have been detected. Inclusion criteria required participants to:

- be aged 18 years or over;
- reside in Victoria; and
- have recently engaged in drug driving (e.g., within the past 12 months).

Individuals who responded to the advertisements were screened for eligibility and provided more information about the study. The sample consisted of participants with a mixture of the following demographics:

Table 1. Sample Summary of participants

Variable	**n (%)**
Age	Mean = 40 Range: 19 to 72 years
Gender Woman^ Man^ Non-binary	 47 (47%) 50 (50%) 3 (3%)
Location* Major city Inner regional Outer regional	 58 (58%) 34 (34%) 7 (7%)
Aboriginal and/or Torres Strait islander No Yes	 94 (94%) 6 (6%)
Years holding a driver's licence	Mean = 20 Range: 1 to 52 years
Licence type Full drivers licence Provisional 2 (P2) Full drivers licence and motorcycle Full drivers and heavy vehicle Full driving, motorcycle and heavy vehicle Unlicenced	 60 (60%) 7 (7%) 9 (9%) 4 (4%) 8 (8%) 12 (12%)

Results

Participants' reasons for drug driving were varied, however several themes were identified, including, the need to respond to emergency situations, such as escaping domestic violence, social and economic pressures, reliance on transport, normalisation of daily drug use and practical necessity, such as work commutes. The report found that transport factors and needs are closely tied to drug driving, including limited access to alternative transport, such as public transport. Factors such as law and enforcement and associated consequences were identified as a risk, amongst participants, but not necessarily a strong deterrent due to daily life necessities, i.e. work or family commitments. The

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study also found that awareness of drug driving laws is high but there is confusion about specific details, for instance drugs tested for, when a test can be done, penalties and processes, and the new laws relating to medicinal cannabis and driving.

Reassuringly, within this context, participants demonstrated a degree of safety awareness, self-regulation, and harm-reduction strategies, underpinned by an acknowledgment of the risks posed to both themselves and others. This was the case for those in the sample who had been detected drug driving as well as those who were not. This creates a constructive environment in which road safety information and resources can be offered. It also highlights a valuable opportunity for road-safety partners to provide accessible, evidence-based information and resources that support safer decision making.

The study generated valuable insights and opened new and important partnership opportunities. Work is now underway with road-safety partners to prioritise actions across several drug-driving programs and clinical settings, with the aim of strengthening knowledge and supporting safer decision-making among people who use drugs. As these partnerships continue to develop, drug-driving information, resources, and training are hoped to become increasingly accessible through AOD services, ensuring they reach the target audience in the environments they regularly engage with.

Benefits to road safety

Working with the AOD sector can deliver benefits for road safety, as it connects road safety efforts directly with the people, services, and environments where risky behaviours can be identified early and influenced most effectively. The study has generated valuable insights and potentially opened new and important partnership opportunities. Work is now underway with road safety partners to prioritise actions across several drug driving programs and clinical settings, with the aim of strengthening knowledge and supporting safer decision making among people who use drugs and drive. As these partnerships continue to develop, drug-driving information, resources, and training are expected to become increasingly accessible through AOD services, ensuring they reach the target audience in the environments they regularly engage with.

Implications for policy and/or practice

Building on the study's findings, road safety partners have a significant opportunity to collaborate with AOD sector experts to co-design resources that support meaningful conversations between clinicians and clients. Such collaboration can help embed therapeutic approaches into responses for drug driving offenders, enable earlier intervention, and extend reach to drivers who are typically hard to engage. It can also support the delivery of credible and consistent information, enhance training and capability across sectors, and strengthen prevention efforts through shared data and insights. Importantly, these partnerships allow road safety messages to be embedded in the environments where decisions are made, contributing to a clearer and more consistent practice approach.

Conclusion

This research signals a shift in how we understand the behaviours and motivations of people who choose to drug drive. Historically, drug driving interventions in Victoria have relied heavily on enforcement to deter offending and remove impaired drivers from the road network. While these enforcement efforts need to continue to help reduce harm, the findings from this study point to new opportunities for complementary countermeasures and approaches that can influence decision making, support behaviour change, and address the underlying factors that contribute to drug driving.

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Drive change, save lives: insurance data improving road safety

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Abstract
Insurance data can provide road safety insights not usually available to road safety policymakers through traditional channels. Claims data, telematics and consumer research provide insights on the impact and effect of safety infrastructure, vehicle safety technologies and driver behaviour that can inform road safety initiatives. A national road safety initiative using telematics demonstrated that providing motorists with personalised, consistent and sustained feedback on their driving behaviours has improved driver behaviours, particularly for cornering, braking, acceleration and phone usage. Almost half of the ~50,000 participants improved their overall driving behaviour by >5%. Further, the largest improvements were made by drivers with the lowest scores for driver behaviour at the start of the initiative, improving safety for everyone on the roads. The presentation will outline findings from the initiative and opportunities for policymakers to collaborate with insurers to drive behavioural change, and to inform and measure effectiveness of road safety initiatives.

Background
68% of Australian drivers admit to dangerous driving behaviours, with 56% admitting to breaking road laws. (ARSF, 2025.) The economic cost of collision-related road accidents has been estimated at >$30bn per year, including injury and property damage, loss of productivity, and loss of quality of life. (Dept. of Infrastructure, 2022.)

Consumer research in September 2025 focused on what drivers thought would be most effective to reduce or stop distracted driving. 41% of respondents agreed that technological solutions could assist, 35% agreed that an app that rewards good driving behaviours could assist, 33% agreed that more public awareness campaigns could help, and 26% said that seeing the consequences of distracted driving first-hand (through their family or friend being involved in a collision) would change their ways. (Pure Profile, 2025.)

To drive change *inside the vehicle*, we developed a telematics initiative that uses a smartphone-based program to track driving behaviour and incentivise users to driver safer through gamification and incentives. The program calculates a driving score based on ratings for each trip for Acceleration, Braking, Cornering, Speeding, and Phone distraction. The program encourages safe driving through tips to improve these driving behaviours as well as the ability to unlock rewards for a high driving score.

The initiative was promoted to the public through a national media campaign between late September 2025 and early February 2026. During this period there were almost 50,000 voluntary participants and the program captured almost 100 million kilometres of driving data.

Our analysis shows a statistically significant link between increased engagement with the program and safer driving behaviour. The data was analysed to identify improvements in driving performance, trends and areas for improvement. Results and findings were published in national media and have been provided to federal, state and territory policymakers.

Conference theme
Consumer research shows that Australians' driving behaviours can be influenced by technology solutions, rewarding good behaviour and public awareness campaigns.

To drive behavioural change inside the vehicle, we provided drivers with personalised feedback on key driving behaviours and tips on how to improve their performance. The results demonstrated significant improvement across all measured behaviours, especially from lower-scoring participants and regarding driving behaviours that motorists may not be aware of or which have not been the focus of road safety awareness campaigns.

The findings suggest that personalised feedback, incentives and easily-actionable tips on improvement can result in meaningful change in driving performance. Improved driving performance during the initiative resulted in the roads becoming safer for everyone. Results and findings were published in national media and have been provided to federal, state and territory policymakers, and we are keen to partner with those holding shared objectives to drive further improvement across Australia.

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Project description

We developed a telematics initiative that uses a smartphone-based program to track driving behaviour. The program calculates a driving score based on ratings for each trip for Acceleration, Braking, Cornering, Speeding, and Phone distraction. The program encourages safe driving through tips to improve these driving behaviours.

The initiative was promoted to the public via national media between late September 2025 and early February 2026. During this period there were almost 50,000 voluntary participants and the program captured almost 100 million kilometres of driving data.

The data was analysed to identify improvements in driving performance, trends and areas for improvement, with a report published in February 2026. Results and findings were published in national media and been provided to federal, state and territory policymakers.

Findings

The data reveals a consistent and compelling pattern: drivers who began with lower starting scores made the greatest improvements across nearly every behaviour measured.

Participants who started with an overall score under 50 recorded double-digit improvements in acceleration (+11) and braking (+11), alongside meaningful gains in cornering (+6.5) phone use (+2.5) and speeding (+1.5). Similarly, those beginning with scores between 50 and 70 achieved strong improvements – particularly in acceleration, braking and cornering. Drivers with greater room to improve responded most significantly to feedback.

The results show that the initiative succeeded in lifting driving performance for drivers who needed it most. The combination of measurement, awareness and reinforcement helped to close performance gaps – raising lower scoring drivers towards safer driving benchmarks, as well as motivating those with higher scores to maintain their safe habits. Specific findings on driving behaviours are outlined below.

Average Overall Score

- Almost half of participants who improved their overall score gained >5pts; one-third gained >10pts

Acceleration

- >50% of participants improved by >10pts; almost one-third gained >20pts
- Unconscious habits like acceleration are highly responsive to feedback – increasing awareness leads to correction

Braking

- 50% of participants improved by >10pts; 25% improved by >20pts
- With insurance claims data indicating that nose-to-tail collisions are the most common mode of crash, improving braking can have a direct impact on driving conditions and risk

Cornering

- One-third of participants improved by >20pts – the largest gains on any measure
- Drivers are less aware of aggressive cornering, but can adjust when shown their data

Speeding

- 72% of participants improved by <5pts; only 3% improved by >20pts
- Speeding scores at the commencement of the initiative were already strong – >92% of participants already scored 90-100 at the start of the campaign.

Phone Use

- 33% of participants improved by <5pts; only 17% improved by >20pts
- Phone use scores at the commencement of the initiative were already strong – 84% of participants already scored 80-100 at the start of the campaign.
- However, data obtained from users prior to the initiative being promoted indicated significant increase in phone distraction scores, particularly from users with sustained engagement with the app.

Significant improvement by lower-scoring cohort

Drivers who scored between 50 and 70 at the start of the initiative showed significant improvement. At the beginning of the initiative, every participant in this cohort scored within 50-69 for each of the five measured behaviours and for overall score.

By the end of the initiative a significant number of these drivers had improved their behaviours to scores well above where they sat at the start:

- Almost 20% of this cohort increased their scores for braking, cornering and acceleration to 90-100.
- More than 25% of this cohort obtained a Speeding score of >90
- Almost 25% of this cohort improved their Phone Use score to >90.
- ~12.5% of this cohort had improved their overall score to >90.

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The significant improvement in behaviours across this cohort shows that when drivers are provided with insights on their driving performance, they can make meaningful change to improve their behaviours.

Benefits to road safety

Drawing drivers' attention to specific driving behaviours gave them awareness of those behaviours and an opportunity to improve.

The initiative resulted in improved driving behaviour across the participating cohort, particularly for lower-scoring participants. The initiative resulted in the roads becoming safer for all users.

Implications for policy and/or practice

The findings indicate that drawing drivers' attention to their driving behaviours in a personalised, consistent and sustained manner results in improved driving performance.

The driving behaviours that drivers are less aware of showed the most improvement (hard braking, sharp cornering and sudden acceleration). The initiative showed that these can easily be corrected once awareness is raised.

Public road safety campaigns often focus on topics such as speeding and phone use. The data suggests that drivers are highly conscious of maintaining strong scores in these areas, but also that sustained engagement with the program improved scores for these behaviours (especially for lower-scoring cohorts).

The findings suggest that road safety campaigns highlighting specific driving behaviours could provide motorists with improved awareness of their driving performance and opportunities to improve, especially if combined with personalisation and feedback on individual driving behaviours.

Conclusions

Personalised, consistent and sustained feedback on driving behaviours can result in real change, making the roads safer for all. Insurer data can inform road safety initiatives, as well as assist to measure impact. Collaboration between insurers, government and other parties can provide new insights, opportunities to influence driver behaviour and progress shared road safety objectives.

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Innovative web-based intervention to reduce phone use among young drivers

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Abstract
Young drivers are overrepresented in crashes, with phone use while driving a key contributing factor. This longitudinal survey study evaluated the effectiveness of an induced hypocrisy online intervention and/or educational webpage to reduce phone use among 175 (131 F, 42 M, 2 non-binary) young Australian drivers aged 18-25 years (M = 21.69, SD = 2.12). Participants were randomly assigned to one of four conditions: combined webpage and online intervention, online intervention only, webpage only, or control. Self-reported phone use behaviour was measured at baseline (i.e., pre-intervention), 1-week, and 4-weeks post-intervention. A 4 × 3 mixed ANOVA, $F(4.77, 122.40) = 2.68$, $p = .027$, found the combined webpage and online intervention was the most effective intervention at reducing phone use at both 1-week and 4-weeks compared to baseline. This key finding supports this intervention as a promising, cost-effective tool for reducing young drivers' phone use, with potential for broad dissemination.

Introduction
Despite only making up 12% of the NSW population, young people were involved in 20% of crashes that occurred in NSW during 2024 (Centre for Road Safety, 2024). Increased crash risk amongst this age group has been linked to a variety of factors, including engagement in distracted driving behaviours such as phone use (Klauer et al., 2014).

One potential behaviour-change program that can be applied to young drivers' phone use is the induced hypocrisy paradigm (based on cognitive dissonance theory; Festinger, 1957). This paradigm comprises two parts. During the first part, the individual is asked to promote the desired behaviour (i.e., write a pro-attitudinal statement). The second part involves recalling past instances of failure to engage in the desired behaviour (i.e. past transgressions). When the individual is reminded of the times that they failed to practice the behaviour they advocated for, they are confronted with their own hypocrisy (and misalignment of attitudes and behaviour), which in turn, induces dissonance. To reduce the feeling of dissonance, individuals are motivated to change their behaviour to align with the attitude promoted. Historically, the induced hypocrisy paradigm utilised an in-person methodology; however, Gauld et al. (2021) developed an online version of the intervention and found it to be more effective than in-person at eliciting cognitive dissonance and reducing phone use behaviour in a group of 153 young drivers in NSW.

Online educational resources and web-based behaviour change programs are becoming increasingly popular to target health-related behaviours of young people (see de Sousa et al., 2022 for a review) due to the potential for cost-effective mass dissemination to the broader population. For the current project, the research team, along with four creative industries students aged 18 to 25 years, developed a new educational webpage targeting phone use among young drivers (see method section for details). The online intervention then formed a key part of this webpage.

The current longitudinal survey study evaluated the effectiveness of four intervention conditions: (1) online intervention combined with the educational webpage; (2) the online intervention alone; (3) the webpage alone; and, (4) a control. The outcome measure of self-reported behaviour was measured at three time points: (1) baseline; (2) 1-week post intervention; and, (3) 4-weeks post-intervention.

Conference theme
This study supports the theme *From Evidence to Action: Shaping a Brighter Future* by applying an innovative, evidence-based approach to reducing young drivers' phone use. This study considers the *evidence* that young drivers frequently engage in phone use while driving, that current countermeasures do not appear to be sufficient to prevent this risky behaviour, and that the online induced hypocrisy intervention has shown promise as an effective intervention to reduce this behaviour. In this study, we *transformed this evidence into action* by developing an evidence- and theory-based educational webpage including the online intervention targeting young drivers' phone use. An evaluation of this webpage shows that, when combined with the online intervention, it is effective at reducing young drivers' self-reported phone use over a 4-week period. As such, future broad dissemination of the webpage may result in a reduction of young drivers' phone use, and a *brighter future* for all road users.

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Method

Participants (N = 175, 131 F, 42 M, 2 non-binary) were young Australian drivers aged 18 to 25 years old (M = 21.69, SD = 2.12), owned a phone, and had used their phone while driving. In the first survey, participants were randomly assigned to one of four intervention conditions (i.e., webpage with online intervention, online intervention only, webpage only, control). Baseline behaviour was measured pre-intervention and participants were asked about the frequency of their phone use while driving in the past week.

Participants who were randomly assigned to a webpage condition (i.e., webpage with online intervention or webpage only) viewed an educational webpage on the dangers of phone use while driving. The webpage included evidence-based educational information on the dangers of using mobile phones (e.g., short TikTok style videos which challenged five commonly held myths such as 'all my friends do it so it must be OK' and 'talking on the phone is just like talking to a passenger' as well as strategies to prevent phone use while driving), up-to-date crash statistics, and links to related road safety webpages. The webpage content was evidence- and theory-based from previous research (e.g., Gauld et al., 2019; Gauld et al., 2017; Lewis et al., 2016) and developed by the research team in conjunction with young drivers (i.e., University of Newcastle creative industries students aged 18 to 25 years).

Participants who were randomly assigned to the online intervention conditions (i.e., webpage with online intervention, and online intervention only) completed a pro-attitudinal statement about the importance of not using their phone while driving followed by reporting their past transgressions relating to phone use while driving (i.e., the two steps in the induced hypocrisy paradigm).

Post-intervention behaviour was measured 1-week after the first survey (Survey 2; n = 119) and 4-weeks after the first survey (Survey 3; n = 82). Data were collected between June and December, 2025.

Results

A 4 (condition: webpage with online intervention, online intervention only, webpage only, control) × 3 (time: baseline, 1-week later, 4-weeks later) mixed ANOVA was conducted on the outcome variable of self-reported behaviour. Results showed a significant interaction between time and condition $F(4.77, 122.40) = 2.68$, $p = .027$, $\eta_p^2 = .09$. As shown in Figure 1, this significant interaction indicated that the change in behaviour over time was dependent on the experimental condition.

Specifically, for the webpage with online intervention, there was significant decrease in behaviour from baseline (M = 5.32, SD = 1.93) to 1-week later (M = 4.18, SD = 1.79) and from baseline to 4-weeks later (M = 3.77, SD = 2.05), $t(77) = 3.482$, $p = .002$. For the online intervention alone, there was significant decrease in behaviour from baseline (M = 4.83, SD = 1.86) to 1-week later (M = 3.26, SD = 1.88) and from baseline to 4-weeks later (M = 3.78, SD = 1.65), $t(77) = 4.903$, $p < .001$; however, there was a significant increase in behaviour from Time 2 to Time 3, $t(77) = -2.323$, $p = .023$. There were no significant differences in self-reported behaviour at any of the time points for webpage only ($t(77) = .899$, $p = .923$) and control ($t(77) = .426$, $p = .923$) conditions.

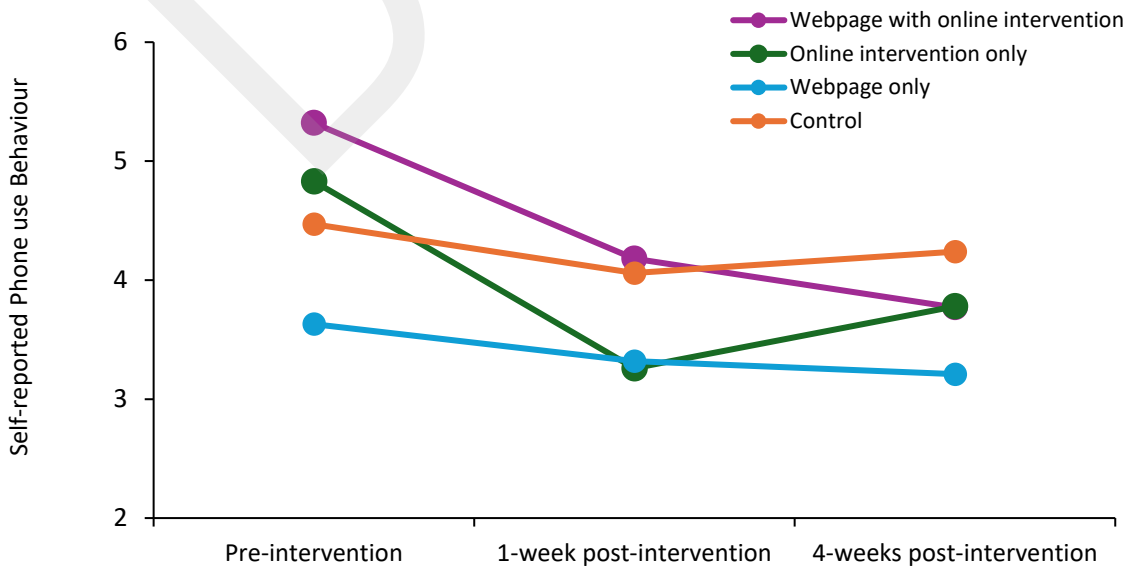

Figure 1. Results from 4 × 3 mixed ANOVA on Self-Reported Behaviour

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Benefits to road safety

This theory-driven, cost-effective, educational webpage with online intervention has the potential to be easily disseminated to the broader population of young drivers. Given this longitudinal evaluation showed that the webpage with the online intervention was most effective at reducing self-reported phone use over a 4-week period, with broad dissemination and uptake by relevant stakeholders, the potential for behaviour change is high.

Implications for policy and/or practice

The development of a theory-driven, cost-effective, online intervention embedded in an evidence-based educational webpage aimed at reducing phone use among young drivers that has the potential to be easily disseminated to the broader population.

Conclusions

Given these encouraging findings, future research should continue to evaluate the effectiveness on an even broader sample of young Australian drivers and investigate whether behaviour change is sustained over a longer timeframe. While this study focused on young drivers and phone use, this theory-driven intervention could be tested on other populations and applied to other risky driving behaviours, such as speeding.

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DRAFT

Anti-speeding message efficacy in reducing speeding intentions in recent speeders

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Abstract
Speeding recidivism presents a major challenge to reducing the significant burden of speed-related road trauma in NSW. An online experimental survey evaluated the effectiveness of messages targeting key barriers to speed limit compliance in a sample of NSW road users with a recent speeding fine. All messages that were tested significantly reduced speeding intentions. Messages that challenged the perception that speeding is 'safe' and unlikely to result in a crash, and that speeding saves time were the most effective in reducing speeding intentions. Recent speeders also indicated that messages delivered by first responders as well as messages depicting crash outcomes would be most persuasive in changing their attitudes towards speeding. The findings will be critical in developing evidence-based campaigns and communications about speeding for recidivist speeders, and will inform an upcoming NSW-wide research trial targeting speeding reoffending through the delivery of behavioural flyers with speeding penalty notices.

Introduction
Globally, speeding contributes to approximately 54% of road fatalities (Fondzenyuy et al., 2014), and speeding is the biggest behavioural contributor to trauma on NSW roads. In 2024, excessive or inappropriate speed was a factor in 39% of fatal crashes and 23% of serious injury crashes in NSW. Further, speeding recidivism remains a significant challenge to address. During 2023-24, 16% of people who received a camera-generated speeding fine in NSW had more than one speeding offence during that period. There is currently limited evidence on how to effectively reduce speeding reoffending, despite a wide range of educational, enforcement and deterrence measures in place.

Some level of speeding is perceived as normal, commonplace and acceptable by many road users. Indeed, one Australian study found that around half of all drivers reported regularly exceeding the speed limit in certain circumstances (Stephens et al., 2017). Speeding behaviour is also habitual in nature, with research indicating that past behaviour is the strongest predictor of both speeding intention and behaviour (Rachad et al., 2024). Further, several robust barriers to speed compliance have been identified in the literature (Huang, et al., 2023; Peterson & Gaugler, 2021; Schroeder et al., 2013) and Transport for NSW's (TfNSW) own attitudinal research. The risks of speeding are often underestimated and prove to be a key barrier in speed compliance. Many road users view "casual speeding" as low-risk and distinguish it from deliberately dangerous speeding. Some believe they are unlikely to be caught or see enforcement as revenue raising rather than a safety measure, reducing trust in speed cameras and speed limits. Others speed because they think it saves time. Anti-speeding messages that target and challenge these speeding enablers may be a potential avenue to reduce speeding intentions and subsequent speeding behaviour.

The primary aim of the research was to develop behavioural anti-speeding messages that challenge barriers to speed compliance, and test their effectiveness in reducing intentions to speed in a cohort of NSW drivers and riders with a recent speeding fine history. A secondary aim was to assess whether message effectiveness differed between subgroups of interest (e.g., repeat offenders, high range offenders).

Conference theme
The research is closely aligned with the conference theme *From Evidence to Action: Shaping a Brighter Future.* Evidence from this research on message effectiveness will be directly put into action in an upcoming NSW-wide randomised controlled trial targeting recidivist speeding offending in collaboration with the Behavioural Insights Unit (BIU) in the NSW Department of Customer Service and Revenue NSW.

Method

Message development
TfNSW engaged the BIU to conduct the research. To develop the anti-speeding messages for inclusion in the primary survey, a preliminary customer sentiment survey of 850 NSW residents was conducted, identifying top barriers to driving at a compliant speed, which were validated against the research literature. The top four barriers identified were;

believing that speeding will save time, believing that speeding is 'safe' (i.e., won't lead to a crash), believing that being caught speeding is unlikely, and believing that speed cameras are not fair. Two anti-speeding messages to target each of the top four barriers to speed were developed through a co-design workshop with subject matter experts on speeding from TfNSW. Six focus groups were run with NSW drivers with a history of speeding (n=18), to user-test the eight messages. Messages were refined for the primary survey based on analysis of key themes arising from the focus groups (Figure 1).

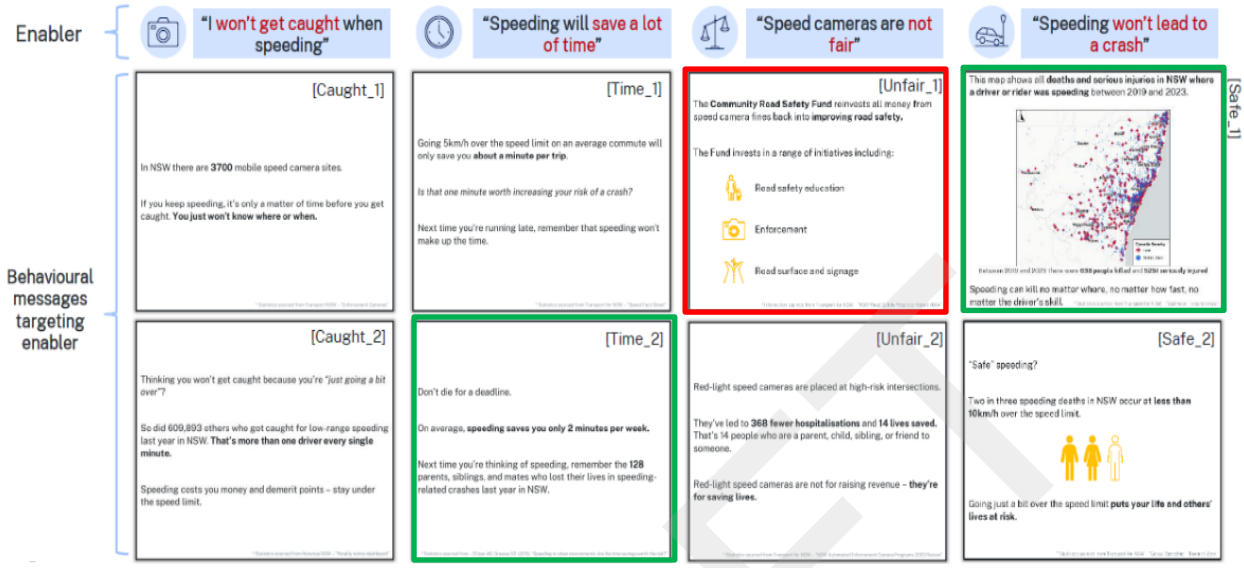

Figure 1. Survey messages targeting each of the four top enablers to speeding
Source: NSW BIU (reproduced with permission). Green = most effective. Red outline = least effective.

Respondents

Survey respondents were 413 NSW drivers and motorcycle riders who had received at least one speeding fine in NSW in the last 3 years. Respondents also had to be aged 18 years or over, live in NSW, have a valid or suspended NSW driver or rider licence, and plan on driving or riding in NSW in the next 30 days to be eligible. Respondents were recruited via two panel providers, Askable and PureProfile. The survey took 15-20 minutes and was run in late 2025. The survey protocol was approved by the BIU Executive Review Panel.

Survey questions

Respondents rated their agreement with the top 4 enablers for speeding on a 5 point-scale (1= strongly disagree, 5 = strongly agree). They then rated their baseline intention to drive faster than the speed limit in the near future on sliding scale anchored at 0 = very unlikely to 10 = very likely. They were then presented with the 8 anti-speeding messages in a random order. For each message they rated how likely they were to drive faster than the speed limit in the near future after viewing the message. After seeing all messages, they ranked them from most to least effective, and answered an open text question about the effectiveness of their top- and bottom-ranked messages. Finally, respondents answered questions about their preferences for the message channel (e.g., TV, social media), message source (e.g., Transport for NSW, NSW Ambulance and paramedics) and images to accompany messages.

Results

Barriers to driving at a safe speed

61% of respondents reported that they were more likely (than not) to speed in the near future, with baseline intentions to speed significantly higher for repeat offenders compared to respondents with only 1 fine. Of the barriers to driving at a safe speed, "I think I will save a lot of time" was endorsed most (with 50% of respondents agreeing), followed by "I don't think I will crash (i.e., I can speed safely)", endorsed by 39% of respondents. The other enablers "I don't think I'll get caught" and "I think speed cameras are unfair (e.g., they are just 'revenue raising' machines)" were each endorsed by 31% of respondents.

Message effectiveness

All eight messages significantly reduced respondents' intentions to speed from baseline ($p < 0.001$). The two messages that produced the largest reductions in speeding intention (29% and 28% respectively) targeted the strongest enablers of speeding (saving time, and 'safe' speeding, see Figure 1). These messages were ranked in the top three by over 50% of respondents, and reduced speeding intentions across all subgroups. The least effective message with the smallest reduction in speeding intention (10%) focused on the fairness of speed cameras and the allocation of fine revenue.

Thematic analysis suggested this was due to respondents' scepticism about revenue being reinvested in road safety. Subgroup analyses revealed that most messages were more effective for drivers living in metropolitan areas compared to regional areas. Most messages targeting saving time saving and the fairness of cameras were more effective for high-range offenders with an over 20km/h the speed limit fine in the last three years, compared to respondents who had not. Messages were equally effective for all other subgroups of interest (gender, age, Aboriginal and/or Torres Strait Islander identification, CALD identification, and repeat offender status).

Formats and messengers

First responders comprised three of the four most preferred messengers for delivering anti-speeding messages. 54% of respondents believed that NSW Ambulance/Paramedics would be most persuasive, followed by NSW Police force (44%), family/friends/peers (42%) and doctors/ medical staff (32%). Respondents also indicated that messages depicting crash outcomes such as an image of a crash scene (endorsed by 49.9% of respondents) or an image of someone receiving medical care after a crash (48.7%) had the greatest potential to reduce their speeding. Roadside advertising and social media were the most preferred channels for delivering anti-speeding messages, endorsed by 59% and 51% of respondents respectively.

Benefits to road safety

Given the significant impact of speeding in road trauma, improving attitudes towards speeding and reducing speeding behaviour remains an ongoing priority for the NSW government. The findings will inform the design of TfNSW's future speeding campaigns and public communications, ensuring messages more effectively influence attitudes and behaviours.

Implications for policy and/or practice

The findings on message effectiveness will also inform a NSW-wide randomised controlled trial of behavioural flyers, assessing whether evidence-based anti-speeding messages delivered with penalty notices reduce reoffending compared with standard notices alone. Similar trials in other jurisdictions have found flyer interventions can be a powerful and low-cost tool in reducing recidivism (Bates et al., 2023; The Behavioural Insights Team, 2017). For example, in the Queensland trial (Bates et al. 2023), people over 25 who received a flyer with their fine were 11% less likely to get a subsequent speeding fine in the next 12 months, compared to people who received the standard fine only. A reduction in speeding of a similar magnitude in NSW may contribute to a reduction in speed-related road trauma.

Conclusions

The current research provided rich insights into the effectiveness of various anti-speeding messages for recent speeders, and key subgroups of interest. The findings highlight new opportunities to develop and target more effective communication approaches for speeding behaviour, and will be critical to inform the implementation of messaging within an upcoming NSW-wide randomised controlled trial targeting speeding recidivism.

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DRAFT

Exploring pedestrian safety perception: a virtual reality study

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Abstract
Understanding how individuals perceive safety in urban environments is important for guiding urban designers in creating safer urban environments and gaining public acceptance for those environments. This study explored how pedestrians' safety perceptions aligned with objective safety measures of street designs. Participants were exposed to three levels of urban environment safety in virtual reality. Participants felt safer as objective safety levels increased. Women perceived nighttime as less safe compared to males, but only in the least safe environments. This study extends previous research by providing a method for systematically assessing the safety perceptions of the 'standard' designs provided in the Global Street Design Guide (GSDG).

Introduction
In Australia, in 2024, there were 174 pedestrian road deaths, around 10% higher than the previous year. Unsurprisingly, pedestrian fatalities are more likely to occur in built-up urban areas, where pedestrian activity is greatest. These areas often suffer from car-centric planning (Ewing & Dumbaugh, 2009), characterised by elements such as wide streets and high speeds. While there is a well-developed literature on the effectiveness of infrastructure design and interventions to improve pedestrian safety in built-up urban areas, implementation is often let down by funding and policy limitations, as well as inadequate data on pedestrian behaviour (Sharma & Dehalwar, 2025). Because of this imperfect safety situation for pedestrians it is important to understand how people make choices about where to walk. One way of investigating this issue is to study how peoples' perception of risk relates to the objective risk to a pedestrian from a particular road environment. Furthermore, there is additional value in understanding peoples' comfort with urban walking environments as this could be leveraged in order to gain public acceptance of safer designs and to encourage increased walking, an oft cited health and environmental goal.

Yao et al. (2025) found that pedestrians feel more at risk when their view is dominated by high-speed vehicles. Objectively safer features, such as narrower lanes and roadside barriers increase pedestrians' perception of safety (Llinares et al., 2020; Martinez et al., 2024). Conversely, pedestrians may also erroneously calibrate their safety perceptions against what are actually safety-neutral aspects of the environment such as the presence of leisure activities, and whether the environment is well-maintained (Bennetts et al., 2017; Yao et al., 2025; Kim et al., 2024). More problematically, Cho et al. (2009) found that people sometimes perceived environments with low vehicular crash rates as more dangerous, while high-crash environments were perceived as safer.

There is now a detailed reference for designing and assessing the objective safety for pedestrians in urban environments, in the form of the iRAP Star Ratings of NACTO-GDCI's Global Street Design Guide (iRAP, 2017). However, there is as yet no evidence about how risk perception is correlated with these objectives risk assessments. The current study created virtual reality (VR) walkthroughs of some of these urban designs and asked people to rate them on a continuum of perceived riskiness, with the aim of establishing the relationship between objective and perceived risk for pedestrians across different street designs.

Conference theme
This study provides some of the first evidence about how people perceive pedestrian risk for GSDG street layouts. Ultimately the data from this research program will allow practitioners to leverage this knowledge to change street designs so that objective and subjective safety align, thus gaining public acceptance for these designs so as to optimise the potential for walking uptake in safe environments.

Method
In 2025 we recruited participants (N = 17) studying undergraduate degrees in Western Australian universities. No participants were excluded from the study. Participants were aged 18 to 24 years (M =19.9, SD = 2.03; female = 8, male = 9). The study was approved by the University of Western Australia Human Research Ethics Committee (2025/ET000344).

Participants completed the experiment using a HTC Vive virtual reality headset. A single controller was used to navigate the Qualtrics questionnaire within the virtual desktop. A single base station was used to detect the location of the headset and was calibrated to the floor so that the height of the participant was emulated within the simulation. The headset was connected to a high-end Windows 11 laboratory computer running SteamVR. The 360° videos were run

using the Steam application, DeoVR, with the 360° lateralisation view setting turned on. Participants were required to stand approximately 1 metre away from the base station. The VR headset was fitted tightly so that participants' vision through the lenses was clear. The headphones were securely clamped over participants' ears with the volume set to maximum.

The Pedestrian Safety Perception Questionnaire (PSPQ) used was a 9-item questionnaire adapted from three pre-existing questionnaires. Item responses were measured on a 5-point Likert scale, with lower item responses indicating lower perceived safety. Item responses on 1, 2, 3 and 9 were reversed-coded. The PSPQ's internal consistency was calculated across the three objective safety levels (1-, 3- and 5-star), and showed good reliability (α = .92, .92, .84, respectively).

The experimental design was a 3 (Objective safety: 1-, 3-, 5-star iRAP rated street designs) x 2 (Gender: female, male) within-between mixed design. The dependent variable was safety perception, measured using the PSPQ. Some examples of the stimuli and the GSDG designs they are derived from are shown in Figure 1.

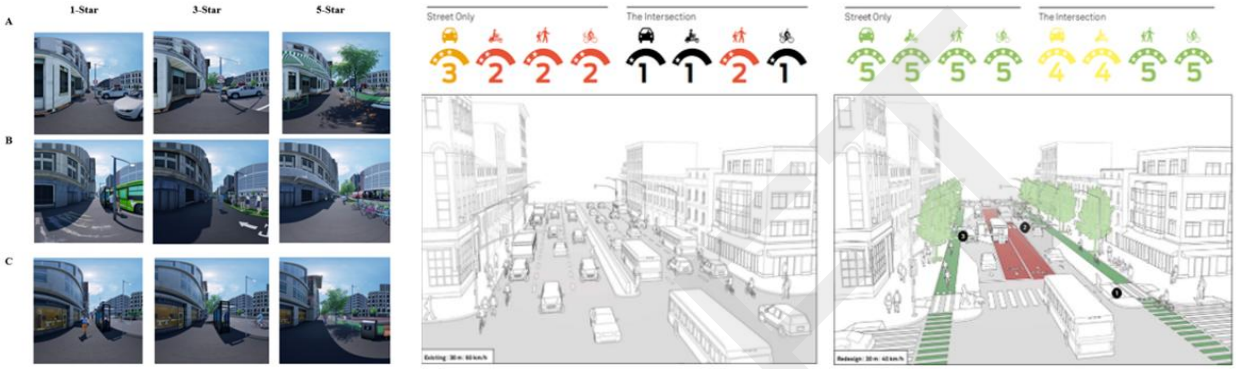

Figure 1. VR stimuli and GSDG design examples

Results

A 3 x 2 mixed measures ANOVA was conducted to assess the effect of safety level on safety perception. Levene's test of homogeneity of variances and Mauchly's test for sphericity were not violated, therefore corrections were not required. The ANOVA revealed a significant main effect of safety on safety perception, $F(2, 30) = 13.56$, $p < .001$, $\eta^2_p = 0.48$. There was no significant interaction between gender and safety level, $F(2, 30) = 0.79$, $p = .46$, $\eta^2_p = 0.05$. Follow-up post-hoc tests revealed significant differences between 1 and 3-star, $t(15) = -2.60$, $p = .02$; 1 and 5-star, $t(15) = -4.99$, $p < .001$; and 3 and 5-star environments, $t(15) = -2.91$, $p = .01$. These results demonstrate that overall safety perceptions significantly increase at each consecutive level of safety (Figure 2).

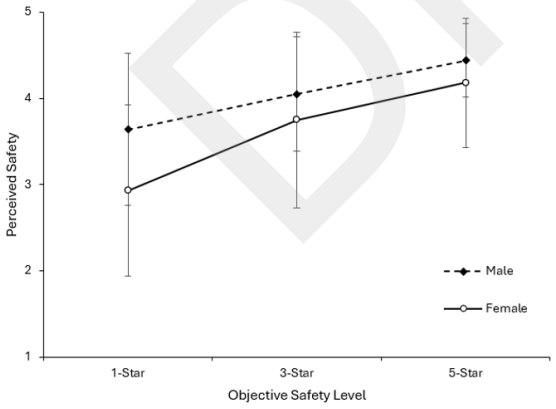

Figure 2. Safety perception of different safety level streets

The PSPQ contained a specific question about safety at nighttime. A further 3 x 2 mixed measures ANOVA was conducted to determine the effect of safety level on safety perception at nighttime. Levene's test of homogeneity of variances and Mauchly's test were not violated. The ANOVA revealed a significant main effect of safety on nighttime safety perception, $F(2, 30) = 14.62$, $p < .001$, $\eta^2_p = 0.49$. There was a significant interaction between gender and safety level, $F(2, 30) = 5.35$, $p < .05$, $\eta^2_p = 0.26$ (see Figure 3). Post-hoc tests revealed significant differences between 1-star and 3-star environments, $t(15) = -3.08$, $p = .02$, and 1-star and 5-star, $t(15) = -5.17$, $p < .001$, showing that pedestrians' nighttime safety perceptions increased significantly up to the 3-star level of objective safety. Females reported significantly lower nighttime safety perception than males, but only at the 1-star level, $t(15) = -4.16$, $p = .01$ (Figure 3).

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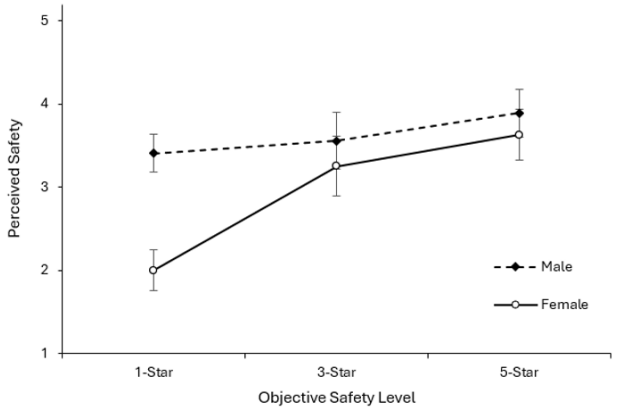

Figure 3. Nighttime safety perception

Benefits to road safety

The approach and methods pioneered in this study provide a way of assessing how people perceive the safety of environments in which they interact as a pedestrian.

Implications for policy and/or practice

Results from this approach can be used to create environments in which perceived safety is congruent with objective safety, thus encouraging public acceptance and safer pedestrian choices. It also allows designers to test how design features can be manipulated to encourage pedestrian activity. The results highlight the need to consider gender differences in understanding how pedestrian safety is perceived.

Conclusions

These findings align with previous research showing that pedestrians' safety perceptions are often congruent with the objective safety of urban environments (Llinares et al., 2020; Martinez et al., 2024; Yao et al., 2025), but also significantly extends previous research by providing a method for systematically assessing the safety perceptions of the 'standard' designs provided in the GSDG. Future work will focus on systematically manipulating environmental features to identify 'misleading' safety cues and to maximise the congruence of perceived and objective safety.

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DRAFT

ADAS safety benefits: a severity-based motor insurance pricing framework

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Abstract

Advanced Driver Assistance Systems (ADAS) are increasingly deployed in passenger vehicles. However, these safety benefits are rarely reflected in motor insurance pricing structures, even though their repair costs are often incorporated, leading to higher premiums for newer vehicles. As a result, these technologies may be perceived as an economic burden rather than a safety gain, limiting the incentives for consumers to adopt safer vehicle technologies. However, ADAS are likely to provide significant benefits in reducing injury severity burdens and hence such safety benefits should be identified to encourage adoption of technologically advanced vehicles. To address this research gap, this study develops an ADAS sensitive insurance pricing framework that translates the safety benefits of ADAS into policy-relevant premium discounts. Using Compulsory Third Party (CTP) insurance data from Queensland, Australia, the study links real-world injury claim records with vehicle-level ADAS information, including Autonomous Emergency Braking (AEB), Forward Collision Warning (FCW), Lane Keeping Assist (LKA), and Lane Departure Warning (LDW) to evaluate their effects on injury claim severity. A joint econometric modelling framework is used to quantify how ADAS technologies influence injury claim severity while accounting for technological interactions between claimant and at-fault vehicles involved in crashes. The estimated severity effects are then translated into loss relativities inform insurance premium discounts associated with different ADAS technology packages. To the best of the authors' knowledge, this study is among the first to derive pricing-relevant ADAS loss relativities while accounting for technology interactions between claimant and at-fault vehicles. Results indicate that vehicles equipped with frontal and rear collision mitigation (AEB/FCW) and sideswipe collision mitigation (LKA/LDW) are associated with lower claim severity. Under existing ADAS penetration, these technologies correspond to pure premium reductions of approximately 0.95% for frontal and rear collision mitigation, 4.02% for sideswipe collision mitigation, and 4.93% when both packages are present. By converting safety benefits into pricing-relevant discount structures, the study is among the first to demonstrate how vehicle technology can be incorporated into insurance pricing and policy design to incentivize the adoption of safer vehicles.

Background

Recent advances in ADAS offer promising opportunities to improve road safety outcomes. Empirical studies have reported substantial safety benefits associated with these technologies, including an 18% reduction in all-severity crashes for vehicles equipped with LDW and a 22% reduction in rear-end crash risk for vehicles equipped with FCW (Cicchino, 2018, 2023). Evidence for AEB also suggests reductions in rear-end crashes, although some estimates were not statistically significant (Cicchino, 2023). Despite growing evidence on the safety benefits of ADAS, insurance pricing frameworks rarely translate these benefits into explicit premium incentives. Instead, higher repair costs associated with ADAS components are often incorporated into premiums, increasing the financial burden on vehicle owners and weakening the role of insurance pricing as a mechanism to encourage the adoption of safer vehicle technologies. Further, in multi-vehicle crashes, injury outcomes are jointly determined by the interaction between both claimant and at fault vehicles. Consequently, modelling approaches that treat vehicle technologies independently provide limited insight into how combinations of safety technologies influence injury severity and compensation outcomes. To address this limitation, this study links ADAS technology bundles with third-party bodily injury claim severity using Compulsory Third Party (CTP) insurance claims data from Queensland, Australia. By explicitly accounting for the presence of safety technologies in both interacting vehicles, the analysis for the first time provides evidence to support the design of technology-sensitive insurance pricing and policy holder discounts.

Conference theme

This research translates empirical evidence on vehicle safety technologies into actionable insights for road safety policy and motor insurance pricing. By quantifying reductions in injury-related claim severity associated with ADAS-equipped vehicles, this study provides a basis for translating safety benefits into insurance premium discounts. The proposed framework demonstrates how real-world insurance claims data can be used to design technology-sensitive pricing incentives that reward vehicles equipped with effective safety technologies encouraging the uptake of safer vehicles while supporting broader efforts aimed at reducing the societal and economic burden of road trauma.

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Method

A joint Log Linear- Generalized Extreme Value (GEV) modelling framework is proposed to examine the impact of ADAS packages on crash-related claim severity using CTP data from Queensland, Australia, covering finalized claims during financial years 2021/22–2023/24. The sample includes 8,717 claims from crashes involving light passenger vehicles. Claim severity is modelled as a function of ADAS technologies present in both claimant and at-fault vehicles to capture interaction effects in multi-vehicle crashes. The study focuses on (1) Front/Rear Collision Mitigation (FRCM), consisting of AEB and FCW, which are designed to mitigate rear-end and longitudinal crashes, and (2) Sideswipe Collision Mitigation (SCM), consisting of LKA and LDW which address lane-departure and lateral crash risks. Vehicles may be equipped with multiple ADAS packages simultaneously, resulting in multiple discreteness in technology configurations. To capture this characteristic, ADAS package availability is modelled as a bundled choice set rather than as mutually exclusive single-feature indicators. In the joint framework, claim severity is modelled using a log-linear regression specification with the logarithm of gross claim cost as the dependent variable as: $\ln(\text{Claim severity}) = \beta_c A_c + \beta_f A_f + \beta_{cf}(A_c A_f) + X\gamma + \varepsilon$, where $A_c$and $A_f$denote the presence of ADAS packages in claimant and at-fault vehicles. ADAS package availability is modelled using a Generalized Extreme Value (GEV) discrete-choice formulation to represent the selection and coexistence of technology packages across vehicles. The two components are estimated jointly to allow for correlated unobserved factors influencing both technology configuration and injury-related claim costs. This joint framework enables the identification of economically interpretable severity effects associated with different ADAS package combinations across claimant and at-fault vehicles, providing a basis for evaluating the implications of vehicle safety technologies.

The pure premium relevant to ADAS packages are computed by using results from the claim severity component of the joint model. Specifically, the pricing-relevant marginal severity effect attributable to equipping the insured vehicle is $\Delta^{pricing} = \beta_c + \beta_{cf}\pi_f$, with $\pi_f = P(A_f = 1)$ representing the empirical prevalence of the technology among at-fault vehicles. Since severity is log-transformed, the corresponding loss relativity is $LR = \exp(\Delta^{pricing})$, and the pure premium discount equals $(LR - 1) \times 100$. The total premium consists of the pure premium, expenses, and risk loading, with the ADAS discount applied only to the pure premium component via the estimated loss relativity.

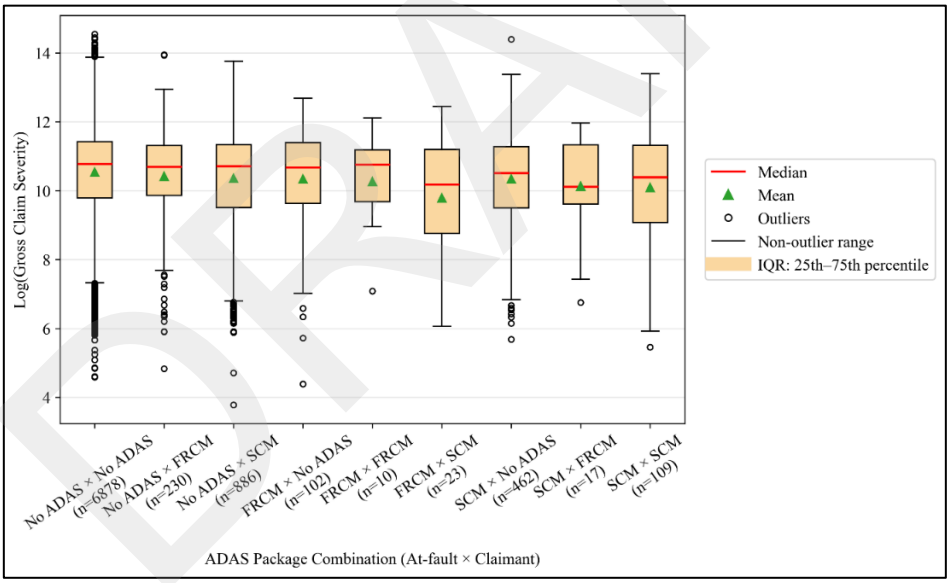

Figure 1. Distribution of log gross claim severity across joint ADAS package configurations

The Figure 1 shows the the distribution of log gross claim severity across combinations of ADAS packages present in the claimant and at-fault vehicles. The highest median claim severity and the greatest upper-tail dispersion occur when neither vehicle is equipped with ADAS, indicating a higher concentration of severe and high-cost injury claims. When FRCM packages are present on either the claimant or at-fault vehicle, the distribution of claim severity shifts downward with the largest reduction occurring when both vehicles are equipped with FRCM, suggesting that interacting safety technologies contribute to lower injury-related claim costs. The presence of SCM package is also associated with a lower claim severity, although the magnitude of the shift appears smaller than FRCM package. Overall, the figure indicates that joint technology configurations influence both the central mass and the tail behavior of injury claim costs, highlighting the importance of considering the safety technologies present in both interacting vehicles.

Results

The joint econometric model is developed based on the exogenous variables which are statistically significant at a 90% confidence interval. Both the FRCM and SCM packages are associated with reduced claim severity when equipped in either the claimant or at-fault vehicle. The interaction term also suggests potential complementarity effects when FRCM

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technologies are present in both vehicles involved in a crash. After controlling the crash characteristics, the three main findings include:

- FRCM package corresponds to a 0.95% reduction in pure premium.
- SCM package corresponds to a 4.02% reduction in pure premium under existing ADAS penetration.
- When both packages are present, the combined effect corresponds to an approximate 4.93% reduction in expected claim severity relative to vehicles without these technologies.

The comparatively larger reduction associated with the SCM package may be explained by crash biomechanics. Lateral impacts and lane-departure related crashes often produce more severe injuries as the side structure of vehicles provides less deformation space than frontal zones, resulting in greater structural intrusion and occupant loading (Woolley et al., 2022). SCM technologies are designed to mitigate mostly sideswipe and rollovers which are frequently associated with high injury severity and medical costs (Sternlund et al., 2017). By contrast, FCRM package primarily target rear-end crash configurations, which typically involve longitudinal impacts where modern vehicles incorporate optimized frontal energy absorption structures and restraint systems.

Benefits to road safety

To the best of the authors' knowledge, the study is amongst the first to demonstrate that vehicle safety technologies can produce measurable reductions in injury claim severity, highlighting their contribution to safer road transport systems. By preventing or mitigating high-impact crash scenarios, ADAS technologies help to reduce injury severity and improve post-crash health outcomes. Results provide real-world evidence supporting the effectiveness of modern vehicle safety technologies and reinforce the importance of promoting the uptake of advanced safety features within the vehicle fleet. As these technologies become more widely adopted, their cumulative impact could contribute significantly to reducing the societal and economic burden of road trauma.

Implications for policy and/or practice

The results provide several implications for road safety policy and insurance practice. First, the demonstrated reductions in injury claim severity support continued policy efforts to accelerate the adoption of advanced safety technologies in passenger vehicles through regulatory initiatives such as ANCAP. Second, the estimated loss relativities provide a basis for incorporating ADAS technologies into actuarial pricing frameworks, enabling insurers to develop technology-sensitive premium structures. Finally, the study highlights the importance of ongoing monitoring of emerging vehicle technologies using real-world insurance data to ensure that their safety benefits are realized as penetration increases across the vehicle fleet.

Conclusions

By translating ADAS safety benefits into pricing-relevant loss relativities, this study demonstrates how ADAS-related reductions in injury claim severity can inform technology-sensitive insurance premium discounts through a robust methodological framework. Integrating vehicle technology information with insurance data provides an evidence-based pathway for insurers and policymakers to align financial incentives with road safety objectives and encourage the adoption of safer vehicles. As ADAS technologies become more prevalent across the vehicle fleet, incorporating their safety benefits into insurance pricing structures can play an important role in supporting road safety policy goals and reducing the societal and economic burden of road trauma.

Acknowledgement

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DRAFT

Complementary opportunities to diversify motorcycle rider education

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Abstract
Insufficient rider skill and experience is proposed as the root cause of motorcyclist overrepresentation in crash statistics. While some riders gain sufficient skills and experience, others do not, revealing disparity in how riders develop skills. The motorcycle training and licencing process provides only a base level of skills and understanding; further skills development is needed. A policy review of existing motorcycle rider training and education showed a gap in the availability of post-licencing rider training options. A review of concepts in skills development provided guidance: the importance of knowledge-building, targeted at mid-level riders, was found to be valuable for developing mid-level skills. Based on these findings, this submission proposes a microlearning framework for mid-level motorcycle rider education (complementary to existing rider training), via a modern platform such as a YouTube channel. This approach aligns with recent research on motorcyclist attitudes, and would diversify motorcycle rider education options, addressing equity concerns.

Introduction
Motorcycle riders are overrepresented in crash statistics in Australia, accounting for 24 per cent of all road deaths in Australia, despite accounting for only 4.5 per cent of registered vehicles. The statistic is consistent with previous years, with research regularly attributing numerous factors including rider protective gear, visibility to other vehicles, inexperience, instability under braking, and risky behaviour. (An additional factor, road surface issues, could be considered separate from the aforementioned factors for the purpose of this submission.)

The data indicates younger motorcyclists (riders in cohort 17–25 years of age) are more at risk. This age-based risk factor contrasts with the perseverance of experienced motorcycle riders. That is, it's observed that while some riders gain sufficient skills and experience, others do not. Potentially, some riders may be disadvantaged in this regard – if so, this reveals disparity in how motorcycle riders develop skills and experience.

This submission proposes that insufficient rider skill and experience is the root cause of motorcyclist over-representation in crash statistics, accounting for all the nominated collective factors (excepting road surface issues). Disparities in post-licencing experiences of riders is therefore an important issue for riders gaining skills and knowledge; without any changes, trends in motorcycle rider crash statistics may remain unchanged.

Conference theme
This submission is a policy review of motorcycle rider training and skill development in Australia. It identifies gaps experienced by riders and proposes new actions as complementary measures to improve rider skills. The intent is to address the root cause of insufficient skills and experience. By taking evidence to action, there is opportunity to increase rider knowledge and awareness, to assist upskilling of motorcycle riders. This could improve equity in rider skills development and assist meeting the 2030 targets for death and serious injuries.

Project description
A policy review was undertaken of existing motorcycle rider training and education options in Australia as at late-2025/early-2026. The review included existing training programs and the availability of post-licensing training and knowledge development available to riders. The findings were compared against established concepts in skills development (particularly regarding development of complex skills), to aid in understanding how experienced riders gain knowledge. The intent was to identify gaps in current rider skills and knowledge development, and in turn potential measures to support rider upskilling – specifically measures that would be complementary to (not replacement of) existing training.

Findings

Review of existing motorcycle rider training and options for skills development
Existing motorcycle rider training programs for licencing are comprehensive. The tiered structure balances practical-based physical skills development and classroom-based learning on roadcraft and other topics. An unintended feature is the condensed nature of knowledge acquisition, creating a knowledge-retention challenge.

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The post-licensing experience for riders is more varied. No further rider training or education is required after completing a probationary course and test. The onus is on individual riders, with several options identified:

- Advanced rider training courses – excellent for refining technical riding skills, although enrolment is reliant on riders' personal budget circumstances.
- Riding in a group with experienced riders – excellent for receiving tips and potentially coaching, although this option is highly situational (and requires the mentor to have appropriate skills/attitude).
- State-based motorcycle awareness campaigns – likely well-founded (directed by research findings), although content frequency is limited, and in some cases are exposed to contrasting interpretations (e.g. 2014 'Ride to Live' video, with riders as target audience but showing car drivers failing to give way).
- Motorcycle-themed YouTube channels (specifically, videos on riding tips and insights) – although content varies widely across the platform, some examples are interesting (e.g. FortNine video giving practical advice on avoiding collisions with cars not giving way, in contrast to the Ride to Live video).

(Another training option was identified, limited to occupational car drivers in fleet-based logistics industries. Third-party providers take advantage of current technology to deliver modules via video, with providers offering 'microlearning' formats, being short duration and mobile-friendly viewing. Modules focus on highly specific scenarios, with a broad library delivered via incremental release over long timeframes.)

Overall, there is a gap in the availability of options for post-licencing motorcycle riding skills development. Riders with suitable budget or specific personal network are less exposed, which results in equity concerns.

Review of concepts in skills development (complex skills)

A review was undertaken of established concepts in skills development, to assist in understanding how experienced riders gain knowledge. Three concepts were found as relevant in this context, as discussed below.

- Dreyfus Skills Model – this model describes complex skills progressing through five or six skill levels, from novice to expert/master. In the context of this submission, while only deep experience allows riders to progress to a higher-level intuition, mid-level development could be facilitated by knowledge-broadening (e.g. understanding a variety of scenarios, building a bank of information to draw from).
- 10,000-hour rule and deliberate practice – the popular '10,000-hour' concept was considered useful only when also incorporating its peer critiques, chiefly that repetition alone is not sufficient – rather, it requires deliberate practice, with feedback essential. Feedback via self-reflection (while less effective than coaching-based feedback) is known to be an effective tool as a feedback mechanism.
- Dunning–Kruger effect – this concept describes the tendency for lower-skilled users to overestimate their skill level; and proposes that further skill development raises greater awareness of the depth of a skill's complexities. In the context of this submission, it emphasises the need to build awareness and knowledge among motorcycle riders, as a means of countering.

On reviewing the above concepts, a useful takeaway is recognising the value of knowledge-building, specifically when targeted at the mid-level of skills development. Knowledge-building targeted at mid-level skills aligns with the Dreyfus Skills Model (i.e. broadening of 'rules'), is relevant for countering overconfidence tendencies (to build awareness in the skill's complexity), and can more broadly foster greater curiosity in motorcycle riding (thereby enabling self-reflection, and in-turn quality practice to support skill development).

Opportunities to diversify motorcycle rider education

By focussing on knowledge-building in post-licensing options for motorcycle rider upskilling, and understanding the various features of existing options, potential measures emerge for consideration. Such measures should be regarded as complementary to (not replacement of) existing rider training courses.

Based on this submission's findings, the concept of a microlearning framework for mid-level motorcycle rider education is considered to have great potential for knowledge-building. Potential platforms for such a framework could be a YouTube channel or similar, with suggested success factors outlined below:

- Structure should borrow from existing microlearning programs for fleet drivers in the logistics industry (given they are established training programs which can be reviewed to understand what works best).
- Focus should be on mid-level knowledge sharing (rather than compliance or general safety awareness) with existing research used to curate topics. Types of topics could include revising material from in-person training, bike setup advice, general riding tips, bad habits, and examples from varied scenarios.
- Content should be segmented into single-topic lessons in short video formats (e.g. several minutes or less) to reduce cognitive load and be generally less onerous to view (compared to long-format content).
- Delivery style should be entertaining, created by partnering with contemporary content creators, to facilitate engagement and return viewing – thereby fostering a culture of continual learning.

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While this proposed opportunity may appear unusual, it is consistent with recent research on motorcyclist attitudes, which revealed social media relating to motorcycling is highly effective in reaching riders.

Benefits to road safety

The proposed opportunity outlined in this submission would incrementally increase mid-level motorcycle riders' knowledge. If sufficiently engaging, it can foster self-reflection in riders which will improve riding practice. By diversifying rider training options, this will support addressing the root cause of motorcycle crash trends, being insufficient skills and experience. Further, an accessible format would address inequity issues, benefiting riders unable to access advanced training courses or appropriate rider networks, diversifying rider training options.

Implications for policy and/or practice

Based on this work, future motorcycle safety campaigns should refocus away from safety awareness and instead focus on knowledge-building. Consideration should also be given to using an appropriate format. For example, past campaigns have included posters/billboards and 15-second videos (for advertising placement), however these formats are too constrained to achieve effective knowledge-sharing. In contrast, longer videos provide more scope to communicate on a topic, while also able to blend-in engaging content. Cooperation between state-based agencies could allow greater scope to produce higher-quality content and achieve higher engagement.

Conclusions

The motorcycle training and licencing process provides only a base level of skills and understanding; further skills development is needed. A policy review of existing motorcycle rider training and education showed a gap in the availability of post-licencing rider training options. A review of concepts in skills development provided guidance; the importance of knowledge-building, targeted at mid-level riders, was found to be valuable for developing mid-level skills. Based on these findings, this submission proposes a microlearning framework for mid-level motorcycle rider education, via a modern platform such as a YouTube channel. This approach aligns with recent research on motorcyclist attitudes, and would diversify rider education options, addressing equity issues.

Adapting this opportunity for car drivers would provide further opportunity to improve road safety outcomes. Partnering with the car insurance industry could provide a means of expediting such an opportunity, given they have significant commercial interest in the outcomes of driver upskilling.

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Developing AusRAP Results for Action

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Abstract
Prioritising road safety action using data-driven insights can help drive road safety outcomes towards 2030, and beyond. In 2025, AusRAP, the Australian Road Assessment Program, released Star Rating results for over 71,000km of roads in a spatial platform, supported by Crash History results and traffic volume. These results were the output of a geospatial model – the AusRAP methodology – developed by Austroads that compiles and publishes mapped routes and consolidated statistics based on AusRAP observation data, historic crash data, a dataset denoting routes of national significance, and a preferred road network dataset. AusRAP's future opportunities for the methodology can continue to build the *evidence*-base for road safety investment, provide greater support for local government practitioners, and enable the measurement and communication of road safety *action* towards 2030 and our goal, an Australia free of high-risk roads.

Background
The Australian Road Assessment Program (AusRAP), assists jurisdictions and local governments in maximising road trauma reductions through the effective management and investment in Australian roads. AusRAP is the Australian version of the International Road Assessment Program (iRAP) and was introduced into Australia by the Australian Automobile Association in 2000. Since 2021, Austroads has managed and coordinated AusRAP and in 2025, released a geospatial dashboard known as the National AusRAP Dashboard (Austroads, 2025), presenting AusRAP results for more than 71,000km of roads across Australia.

In producing this dashboard, Austroads developed a data processing and mapping methodology to collate AusRAP Star Rating results from state and territory road authorities and Crash History results from the Australian Government's National Road Safety Data Hub (National Road Safety Data Hub, 2025). Based on the protocols of the International Road Assessment Program (iRAP), the AusRAP methodology is an automated and scalable process that enriches individual datasets. It provides an informative and engaging spatial resource to inform road safety risk for practitioners and the public alike. Users can interrogate road safety results for entire highways or roads (Roads), specific road corridors (Links), through to road segments up to six kilometres long (Sections).

Each result presents the AusRAP Star Rating results (predictive road environment risk), Crash Density results (serious crashes per kilometre) and Crash Rate results (serious crashes relative to traffic volume). This supports road safety action by blending the internationally recognised Star Rating methodology (iRAP Methodology Reference Guide, 2026) with Australian crash history data to form supporting evidence for decision-making.

Conference theme
By combining elements of predictive risk (Star Ratings) and crash outcomes (Crash History), the AusRAP dashboard enables road safety practitioners to evaluate where the greatest return on road safety investment exists and communicate and track the safety performance of roads over time.

This dashboard, and the underpinning AusRAP methodology, focuses on informing *Action* to reduce road trauma based on a methodology grounded in road safety *Evidence*. Subsequently, AusRAP can be used to prioritise and evaluate effort that *shapes a brighter future* for Australian road safety outcomes in both the short-term and long-term.

Method
To develop the dashboard, Austroads, through agreement with member agencies and Transurban (operator of several private toll roads included within the results), ingested iRAP coded Star Rating output files and tabular relational database outputs of road crashes from the National Road Safety Data Hub.

The Star Rating datasets were overlayed with National Roads (Geoscape, 2025) road centrelines to construct an output that both presents Star Rating results, which is also packaged as a geometry that can be used for analysis in conjunction with other spatial datasets. These geometries were then enriched with Fatal and Serious Injury crash data from the National Crash Data Hub, adding Crash Density and Crash Rate information.

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Data methodology

The AusRAP methodology is built upon the iRAP methodology, ensuring the AusRAP methodology can be leveraged for other RAP programs internationally, benefiting road safety outcomes for all.

The AusRAP methodology is built using a Feature Manipulation Engine (FME, 2025) workflow that:

- Prepares complementary datasets to correlate AusRAP results with a preferred road network dataset and a dataset denoting routes of national significance (the National Land Transport Network).
- Collates and standardises FSI crash data from multiple jurisdictions.
- Reads, cleans, quality-controls, and standardises AusRAP observation data.
- Calculates "Smoothed Sections", compiles Links, and calculates whether observations lie on routes of national significance.
- Calculates statistics, accounting for the prevalence of roadworks.
- Spatially matches crashes to AusRAP Sections, accounting for change over time, crashes at intersections, and affected user groups.
- Compiles and publishes mapped routes and consolidated statistics.

Data challenges

In executing the data methodology, Austroads encountered some data challenges that provide opportunities for future enhancement. The main challenges encountered revolved around data validation within data packages and tables including, but not limited to:

- Standardised date field formats.
- Geo-referenced accuracy (validation of co-ordinates against road locations).
- Numerical values as text.
- Currency of datasets, especially those depicting road networks that change over time.
- Adherence to the iRAP coding specification requirements for distance-based attributes.

Selecting what information to present

By working collaboratively with the AusRAP Community of Practice – AusRAP representatives of each state and territory road agency – the AusRAP project team refined the key information necessary to present results to practitioners and the public alike.

The information presented includes:

- Name of the selected Road, Link, or Section.
- Road Length.
- Vehicle Kilometers Travelled (how much the road is used).
- Percentage of travel on 3-Star or better roads.
- Breakdown of travel and road length, by Star Rating.
- Fatal and Serious Injury crash count (5-years).
- Crash Density and Crash Rate calculations.
- Survey data age.

Presenting complex information for a range of audiences

A key consideration of the National AusRAP Dashboard has been the effective communication of complex information for a range of audiences. Central to this was making road safety data accessible and simple to understand.

To enable this, the AusRAP project team implemented into the National AusRAP Dashboard:

- A selectable list of Roads, Links, and Sections, that users can use to filter specific results.
- A scale-based layering of Roads, Links, and Sections to enable a seamless transition of information detail. The intuitive scale-based layering mixed with selectable road geometries (to display a result) enables users to view results without switching between screens or having to understand the data.
- A standard layout of information, irrespective of the result level selected (Road, Link or Section).
- Various sets of colour visual deficient colour palettes.

Additionally, the AusRAP project team created:

- A detailed step-by-step methodology to support users wishing to know more.
- Several case studies of practical AusRAP and risk assessment applications.

Results

The result was the creation of the AusRAP Collection (Austroads, 2025), which is a single resource bringing together all outputs of the AusRAP methodology (and as detailed above in the method).

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This resource was central to the AusRAP Summary Report (AusRAP Results, 2025) – showcasing a snapshot of quantitative results for 2025 – and will remain a core component of future result updates. The methodology developed enables Austroads to streamline the refreshing of AusRAP results, at scale, resulting in an efficient and timely update of results for members - allowing the provision of the most recent information to practitioners and the public as available. AusRAP results can act as a driver for *evidence*-based decision making and as a repository for tracking and evaluating *action* towards 2030 and our goal, an Australia free of high-risk roads. Furthermore, the communication of evidence and action is available to both practitioners and the public, enabling a more transparent discussion of road safety priorities and progress towards a *brighter future* for Australian road safety.

Future opportunities

With the initial release of the AusRAP results complete, the AusRAP program is expanding its efforts throughout 2026 and 2027 with a focus on standalone Crash History results - including a focus on producing results for local government roads, at scale, across Australia. Central to this expansion of AusRAP is additional spatial functionality that builds on Star Rating, Crash History, and complementary (such as nationally accessible traffic volume) datasets, which presents opportunities to inform both *evidence* and *action*. AusRAP will consider opportunities to support local governments to undertake Star Rating assessments using 'light' tools, and provide Crash History insights (e.g., identify roads of high Crash Density and Crash Rate) that complement local government road safety funding opportunities – reducing effort and targeting the greatest road safety opportunities.

Data applications so far

Austroads, in collaboration with the AusRAP Technical Working Group (TWG), is supporting opportunities to deploy AusRAP Star Rating results in other risk-based methodologies. Current opportunities being explored include the use of Star Ratings to inform effort of the National Heavy Vehicle Regulator and Western Australia's Road Safety Commission. Austroads will continue to explore opportunities with the AusRAP TWG, especially across 2026 and 2027 with effort working towards the release of Crash History results and local government support.

Benefits to road safety

The AusRAP results can enable:

- **Road safety performance tracking** through the update of Star Ratings and Crash History results, over time, and that can be presented in time series.
- **Transparency** of road safety decision making that can help support strong road safety outcomes through focused efforts on where there is the greatest return on road safety investment.
- **Communication** of investment, action, and progress in road safety, over time, and towards goals.
- **Local Government road safety action** by leveraging data to support and promote priority road safety investment decisions.

Implications for policy and/or practice

The AusRAP results can act both as a driver for *Evidence*-based decision making and as a repository for tracking and evaluating *Action* towards 2030 and an Australia free of high-risk roads. Furthermore, the communication of evidence and action is commonly available to practitioners and the public, enabling more transparent discussion of road safety progress towards a *brighter future* for Australian road safety outcomes. Subsequently, AusRAP (and its results) can support policy objectives (including target setting) and support decision making in practice.

Conclusions

AusRAP's methodology and results provide a strong basis to track progress and inform road safety decision making (and the communication of decisions). With 2025 seeing the release of the AusRAP Collection, and with the future opportunities available to AusRAP to further develop Crash History results and supporting tools for local government, AusRAP is well positioned to support Australian road safety *action* through *evidence*-based investment into the future.

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Heavy goods vehicle drivers' views on factors contributing to lorry crashes

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Abstract
Heavy goods vehicles (HGVs) are essential to Malaysia's logistics sector, yet their involvement in road crashes remains a major safety concern. Differences in design and operation between rigid and articulated lorries may result in distinct crash risk patterns. This study examines crash contributing factors for both vehicle types from drivers' perspectives. A nationwide online survey collected 424 valid responses. Exploratory Factor Analysis identified three key components influencing crashes: driver behaviour, vehicle condition, and road and environmental factors. For rigid lorries, fatigue, lack of sleep, reckless driving, brake deficiencies, and tyre bursts were the most influential factors. For articulated lorries, speeding, traffic violations, fatigue, adverse weather, and blind spots showed strong associations with crash risk. The findings reveal that although similar factor categories influence both lorry types, the specific contributing variables differ. This highlights need for targeted safety interventions tailored to each vehicle type to improve road safety outcomes in Malaysia.

Introduction
Heavy goods vehicles (HGVs) play a major role in transporting goods within regions and countries. HGV are defined as any motor vehicle constructed to carry goods with a gross vehicle weight (GVW) exceeding 3,500 kg (Evgenikos et al., 2016). In 2022, there were a total of 1,390,676 goods vehicles registered in Malaysia, accounting for 4% of total vehicle registrations (MOT, 2023).

Despite their importance to the economy, traffic crashes involving HGVs raise safety concerns. In China, HGVs make up only 3% of all registered vehicles, but involved in 19% of all traffic fatalities (Baikejuli et al., 2022). In the European Union (EU), recent report from FreyaSlootmans (2023) found that crashes involving HGVs lead to 14% of fatalities, causing 3,040 lives lost in 2019 and about 90% of the fatalities being other road users, mostly car occupants. In Malaysia, road traffic crashes involving HGVs are increasing. For example, between 2017 and 2019, there were a total of 109,556 crashes involving HGVs, representing a 6.2% rise from 2017 to 2018 and a further 2.65% rise from 2018 to 2019 (MOT, 2020). Despite these minor increments, HGVs are responsible for over 1,000 fatalities each year with more than 80% of those are occupants of other vehicles (Hamidun et al., 2019).

The two main types of HGVs in Malaysia are rigid and articulated lorries. As of 2022, rigid lorries make up 81.7% of all HGV registrations, while articulated lorries account for 18.3% (RTD, 2023). These lorries have different designs to enhance their road performance and practicality. According to the Motor Vehicles (Construction and Use) (Amendment) Rules 2024, an articulated lorry consists of a motor vehicle combined with a semi-trailer or trailer, or multiple semi-trailers. In contrast, a rigid lorry is built to carry its load on its own axles. The two types differ in length and weight, with rigid lorries ranging from 9 to 13 meters long and articulated lorries from 14 to 25 meters, depending on axle configuration. This configuration also affects the maximum gross vehicle weight (GVW). The Weight Restriction Order (WRO) sets the maximum GVW at 33 tonnes for rigid lorries and 53 tonnes for articulated lorries with a semi-trailer.

Truck configuration influences the crash outcomes due to their weight, size, mechanical properties, turning radius, and crash avoidance capabilities (Haq et al., 2021). These characteristics present different challenges, which may result in one type being more frequently involved in crashes. Previous studies in Malaysia, Turkey and Australia found that rigid lorries are the most common type of HGV involved in collisions with other vehicles, often leading to fatalities (Hamidun et al., 2019). In contrast, the other studies show that articulated lorries are more frequently involved in crashes and often result in more severe injuries compared to other truck configurations (Wu et al., 2023).

Previous studies also identified four main contributing factors for HGV crashes, including driving behaviour, road design, environmental conditions and vehicle attributes (Baikejuli et al., 2022; FreyaSlootmans, 2023). A review by Zainuddin, Arshad, Hashim, et al. (2023) stressed that human is the main factor, while vehicle is the least. Additionally, the Ministry of Transport quantified three main causes of crashes in Malaysia, which are human negligence (80.6%), road condition (13.2%), and vehicle elements (6.2%) (MOT, 2023).

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Despite extensive research in HGV related crashes, there remains a gap in understanding crash contributing factors specific to rigid and articulated lorry. The conflicting findings among researchers highlight the need for a comprehensive study between these two vehicles to identify factors specific to each type of HGV. This study aims to assess significant factors contributing involving these vehicles from the driver's perspective. Findings from this study seek to clarify the crash factors involving HGVs for the development targeted safety interventions to improve road safety.

Conference theme

This study supports the ARSC2026 theme "From Evidence to Action: Shaping a Brighter Future" through empirical analysis of crash factors for different HGV types. Findings provide evidence for targeted interventions, improved enforcement strategies, and enhanced safety practices in the commercial transport sector.

Method

An online questionnaire was distributed to HGV drivers across the Malaysia through Malaysian computerized vehicle inspection company (PUSPAKOM) centres. Based on a population of 986,166 Goods Driving License holders, the required sample size was 383. A total of 424 valid responses were obtained. The questionnaire covered demographics, driving experience, crash history, and perceptions of crash contributing factors.

Exploratory Factor Analysis (EFA) was applied to 21 variables measured using a 5-point Likert scale. Principal Component Analysis with eigenvalue >1 and Varimax rotation was used to extract and validate factors. Analysis was conducted separately for rigid and articulated lorries.

Results and Discussion

Most respondents were male, middle-aged, and experienced drivers, with the majority having more than 10 years of driving experience and primarily operating rigid lorries. Only 7.8% reported involvement in crashes within the past 12 months, with most incidents resulting in property damage. This relatively low reported crash rate may reflect underreporting or cautious self-reporting behaviour among drivers.

Exploratory Factor Analysis (EFA) identified three key components influencing crashes for both rigid and articulated lorries: driver behaviour, vehicle elements, and road and environmental factors. This finding aligns with previous studies which consistently highlight these three domains as primary contributors to HGV crashes (Baikejuli et al., 2022; Newnam & Goode, 2015).

Driver behaviour emerged as the most dominant factor for both lorry types. For rigid lorries, fatigue, lack of sleep, and reckless driving showed strong influence. These findings are consistent with Haq et al. (2021), who reported that risky driving behaviours significantly increase crash likelihood among commercial vehicle drivers. Rigid lorries are commonly used in urban operations with frequent trips and time pressure, which may contribute to driver fatigue and sleep deprivation. This condition increases the tendency for risky driving behaviour.

For articulated lorries, speeding, traffic violations, reckless driving, and fatigue were the most influential variables. The stronger association with speeding may be related to long-distance travel and highway operations, where drivers may prioritise delivery schedules. Similar findings were reported by Wu et al. (2023), where speeding was identified as a key contributor to severe crashes involving large trucks.

Vehicle-related factors were the second most significant contributors for both lorry types. Brake deficiencies and tyre bursts were prominent for rigid lorries, while tyre bursts and blind spots were more significant for articulated lorries. These findings are supported by Teoh et al. (2017), who highlighted those mechanical failures, particularly involving brakes and tyres, play a critical role in heavy vehicle crashes. The presence of blind spots in articulated lorries is expected due to their larger size and complex configuration, which reduces driver visibility and increases crash risk (Wang et al., 2022).

Road and environmental factors also contributed to crash risk for both lorry types. Inadequate road signage and insufficient street lighting were identified as important factors, consistent with findings from Newnam and Goode (2015), which emphasised the role of road environment in supporting safe driving behaviour. Adverse weather conditions were particularly influential for articulated lorries, likely due to their higher centre of gravity and reduced stability, making them more susceptible to control loss under challenging conditions.

Overall, while the same three factor categories influence both lorry types, the specific contributing variables differ. Rigid lorries are more affected by fatigue-related factors and mechanical issues linked to operational demands, while articulated lorries are more influenced by speeding, visibility limitations, and environmental conditions. These

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differences highlight the importance of developing targeted safety interventions tailored to each lorry type rather than adopting a uniform approach.

Benefits to road safety

This study highlights key crash contributing factors specific to rigid and articulated lorries. The findings support targeted safety measures such as fatigue management, improved driver compliance, and stricter maintenance practices. Understanding these differences enhances the effectiveness of interventions and reduces crash risks involving HGVs.

Implications for policy and/or practice

Authorities may strengthen enforcement on speeding, reckless driving, and driver fatigue through structured monitoring programmes. Maintenance regulations should emphasise brake systems, tyre conditions, and overloading control. Improvements in road infrastructure, including clearer signage and better lighting, are also necessary. Collaboration between agencies and industry players is essential for effective implementation.

Conclusions

HGVs play a vital role in Malaysia's logistics sector but remain associated with significant safety risks. This study identified three key factors influencing crash likelihood: driver behaviour, vehicle condition, and road and environmental conditions. Differences were observed between lorry types. Rigid lorries were more influenced by fatigue and lack of sleep, while articulated lorries were more associated with speeding and traffic violations. Vehicle defects such as brake failures and tyre bursts were critical for both types, while road conditions also contributed to crash risk. These findings highlight the importance of targeted safety strategies tailored to different HGV configurations to improve road safety outcomes.

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What if we designed this with them, not for them?

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Abstract
Road safety programs are typically designed *for* young people. This paper asks what changes when they are designed ***with*** them. Drawing on a 7-month human-centred co-design process grounded in a systematic evidence base, this paper presents a replicable methodology for translating road safety research into validated solutions. The process involved community discovery with more than 3,400 touchpoints of input, iterative lo-fidelity prototyping, weekly user testing, and quantitative concept validation with 348 young drivers and 411 parents. Three distinct solutions emerged, addressing parent supervision support, structured practice access, and skill development infrastructure, all of which resonated strongly with participants. This paper presents the co-design methodology, the principles it generated, and the implications for how road safety organisations can move from evidence to action through authentic co-creation.

Background
In 2022, Australians aged 15–24 accounted for 19% of all road fatalities while comprising only 11% of the licensed driver population (BITRE, 2023a). Between 2013 and 2023, annual youth road fatalities rose from 225 to 236 (a 7.3% increase) in an era of sustained road safety investment (Australian Government Department of Infrastructure, 2024). A range of studies including a systematic review of 44 international papers commissioned to understand this persistent overrepresentation confirmed a recurring pattern: road safety education programs are frequently developed without community input and rarely evaluated (CARRS-Q, 2025).

Extensive community discovery with more than 3,400 touchpoints of input from young learner drivers, parents, and supervisors revealed why programs underperform: they are designed around assumptions about what young people need, not around the actual experience of learning to drive. Parents enter a high-stakes supervisory role without preparation, training, or tools. Learner drivers' confidence and competence diverge in ways that create risk rather than reduce it. Access to structured practice is unequal, particularly in rural and regional areas. Strikingly, these same challenges emerged independently from community discovery conducted in both Western Australia and Tasmania, confirming they are systemic and consistent across geographically distinct jurisdictions, not isolated to a single context (Young Driver Road Safety Program WA, 2025; Youth Road Safety Project Tasmania, 2025).

Conference theme
Where the companion submission presents the evidence base, this submission demonstrates what happens when that evidence is acted upon. This submission is the foundation of From Evidence to Action: Shaping a Brighter Future by demonstrating what the translation from evidence to action actually looks like in practice. This submission presents the methodology for turning it into something real, a co-design process that any road safety organisation can learn from and apply in designing and delivering road safety education.

Project description

Phase 1: From discovery to design brief
Community discovery findings, drawn from qualitative surveys with 1,060 parents and learners, workshops, interviews, hackathons, and a People's Choice vote with 2,027 responses, were synthesised into a structured design brief. Three intervention points were identified where co-designed solutions could close the gap between what evidence recommends and what learner drivers and their supervisors actually experience: the supervision relationship, access to structured practice environments, and ongoing skill development across the licensing journey.

Phase 2: Co-design and lo-fidelity prototyping
A structured co-design process produced lo-fidelity prototypes for each intervention point, tested with seven parent supervisors through in-depth feedback interviews. Prototypes were deliberately 'rough', the goal was to surface assumptions and test ideas before investing in high-fidelity design. This phase produced three distinct concept directions, each shaped directly by community input rather than expert assumption (Sanders & Stappers, 2008).

Phase 3: Iterative prototype refinement
High-fidelity prototypes were refined through weekly online user testing sessions with 12 rural and metropolitan parents across four rounds of iteration. Ten physical practice prototypes were distributed for in-home testing across

metropolitan and regional areas. Two professional driving instructors and WA Department of Transport and Major Infrastructure representatives reviewed the underlying skills framework for accuracy and completeness. Each round of testing directly shaped the next, a feedback loop that is standard in human-centred design but rare in road safety program development (IDEO, 2015).

Phase 4: Quantitative concept validation

Final concepts were validated through a structured survey reaching 348 young drivers and 411 parents across all licensing stages, from learner permit through to full licence holders aged 18–24. The study tested concept resonance, perceived value, and enhancement suggestions for each solution (Young Driver Road Safety Program WA, 2025).

What co-design produced

The co-design process generated three validated concept solutions, each addressing a gap that community discovery identified and expert-led design had consistently missed:

- A parent-facing digital support platform providing instructor-level guidance, structured lesson planning, and a dual tracking system capturing both supervisor-assessed competency and learner self-reported confidence simultaneously, potentially surfacing a dangerous gap between the two.
- A home-based structured practice kit with physical materials and expert video guides, enabling safe scenario practice without professional instruction, directly addressing cost and access barriers identified by rural and regional families.
- Dedicated practice environments, permanent and pop-up, providing structured practice spaces accessible to families who cannot rely on expensive professional lessons alone, including in regional areas.

What the validation confirmed

- All three concepts resonated strongly with young drivers (Young Driver Road Safety Program WA, 2025).
- Parents were broadly supportive, with specific enhancement suggestions that would address the concerns of those initially uncertain, demonstrating that co-design continued through validation, not just prototyping.
- Concepts were most valued when framed as relationship tools, not driving tools, confirming that the co-design reframe of the problem (from skill acquisition to relational support) was correct.

What the methodology demonstrated

The most significant finding is not about any individual concept. It is that a co-design process grounded in authentic community discovery consistently produced solutions that expert-led design had not. Participants identified needs, shaped features, and validated priorities that were absent from the original design assumptions. This is the core contribution: a replicable model for what it looks like to move from road safety evidence to community-validated action.

Benefits to road safety

This project demonstrates that human-centred co-design is not just an ethical consideration in road safety program development, it is a quality mechanism. Concepts developed with communities outperform those developed for them. The methodology presented here is replicable, scalable, and directly addresses structural gaps – such as inadequate parental support, inequitable access to practice, and the confidence-competence disconnect – that the evidence identifies as key contributors to risks to young drivers.

Implications for policy and/or practice

- Human-centred co-design should be adopted as standard practice in road safety program development. The methodology: discovery, prototyping, iterative testing, and quantitative validation, is replicable by any road safety organisation with community access.
- Supervisor support must be treated as road safety infrastructure. Co-design revealed that parents and guardians want to supervise well but are systematically unsupported. Investing in supervisor capability is one of the highest-leverage interventions available (Simons-Morton & Ouimet, 2006).
- Access equity must be a co-design requirement, not an afterthought. Rural and regional families consistently surfaced barriers that metro-focused design processes would have missed entirely.
- Digital tools in road safety must move beyond content delivery toward adaptive, personalised support that tracks real skill development, confirmed by co-design participants and supported by the literature (Authors removed for blind peer review, 2025).

Conclusions

The evidence says young drivers aged 17–24 are overrepresented in road fatalities. The community said the supervisory relationship is emotionally demanding and practically unsupported. Co-design built the infrastructure to address it, with learner drivers and their supervisors, not for them. The validated concepts are the output. The methodology that produced them is the contribution. Any road safety organisation with the will to listen to its community can replicate it.

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From training to safer roads: evaluating workplace motorcycle safety education

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Abstract
Motorcyclists represent a high-risk road user group in Malaysia, particularly among workers who commute daily by motorcycle. This study evaluates the effectiveness of a structured workplace motorcycle safety training programme delivered to employees of a Malaysian automotive manufacturing company. A pre–post evaluation design was used, involving 153 participants who attended a mandatory 1.5-day training programme. The programme combined classroom-based theory with practical riding exercises covering hazard perception, defensive riding, braking techniques, helmet safety, and common crash risk factors. Participants completed a ten-item knowledge test before and after the training. Results showed a significant improvement in knowledge scores, with the mean score increasing from 5.50 (SD = 1.55) to 7.53 (SD = 1.56) ($p < 0.001$). The findings suggest that workplace motorcycle safety education can effectively improve riders' motorcycle safety knowledge and support organisational road safety initiatives aligned with the Safe System approach.

Background
Motorcyclists represent one of the most vulnerable road user groups globally, particularly in low- and middle-income countries where motorcycles are widely used for daily commuting. Road safety researchers increasingly recognise that reducing road trauma requires a systemic approach rather than focusing solely on individual behaviour. The Safe System approach (International Transport Forum, 2022) has therefore emerged as a dominant paradigm in road safety policy, emphasising that human error is inevitable and that transport systems must be designed to prevent such errors from resulting in fatal or serious injuries.

The Safe System framework highlights the interaction between safer roads, safer vehicles, safer speeds and safer road users in achieving long-term reductions in road fatalities. However, strengthening the “safer road users” component requires improving motorcycle safety knowledge, risk perception and safety culture among road users themselves. Workplace-based motorcycle safety education programmes, particularly those implemented through workplaces, represent a potentially effective strategy for addressing commuting risks among motorcyclists. Despite this potential, empirical evidence evaluating the effectiveness of workplace-based motorcycle safety training remains limited.

The structured workplace motorcycle safety training programme evaluated in this study was developed by road safety subject matter experts from industry. This evaluation focuses on a single implementation of a structured workplace motorcycle safety training programme involving employees from an automotive component manufacturer in Malaysia. Participants were nominated by organisational management and attendance was mandatory as part of the company's occupational road safety initiative. The findings provide evidence on the potential contribution of workplace-based road safety education to strengthening the safer road users pillar of the Safe System framework.

Conference theme
This study directly supports the theme of the Australasian Road Safety Conference 2026, *“From Evidence to Action: Shaping a Brighter Future,”* by translating empirical evidence into practical road safety interventions. The findings demonstrate that structured workplace motorcycle safety training significantly improves riders’ motorcycle safety knowledge, providing measurable evidence of the effectiveness of education-based interventions. By evaluating a real-world training programme using pre–post data, the study bridges the gap between research and implementation. The results offer actionable insights for policymakers, employers and road safety practitioners seeking scalable strategies to reduce motorcycle-related risks among commuting workers. Integrating such training programmes within occupational safety systems can strengthen the “safer road users” pillar of the Safe System approach and support broader national road safety strategies aimed at reducing road traffic injuries and fatalities.

Method
A single-group pre–post evaluation design was used to assess changes in motorcycle safety knowledge following a structured workplace motorcycle safety training programme. The study evaluated one implementation of the programme involving 153 employees from an automotive manufacturing company in Malaysia who regularly commuted by motorcycle. Participants were nominated by company management, and attendance was mandatory as part of the organisation's occupational road safety initiative.

The structured workplace motorcycle safety training programme was delivered by certified trainers who had completed a Train-the-Trainer programme. The programme was conducted over one and a half days, comprising classroom-based theoretical instruction on the first day followed by practical motorcycle riding exercises on the second day. Training topics included hazard perception, defensive riding strategies, braking techniques, helmet safety, and common motorcycle crash risk factors.

Participants completed an identical ten-item multiple-choice questionnaire immediately before the training commenced (pre-test) and immediately after the completion of the training programme (post-test). The questionnaire assessed motorcycle safety knowledge of hazard perception, braking techniques, helmet safety, motorcycle crash risk factors, and safe riding practices. Each correct response was awarded one point, giving a maximum possible score of ten. Descriptive statistics were used to summarise motorcycle safety knowledge scores, and differences between pre- and post-training scores were analysed, with statistical significance set at $p < 0.05$.

Results

The results indicate a significant improvement in motorcycle safety knowledge following the training intervention. The mean pre-training score was 5.50 (SD = 1.55), suggesting moderate baseline knowledge of motorcycle safety practices among participants. After the training session, the mean score increased to 7.53 (SD = 1.56) (Table 1). This represents an improvement, equivalent to approximately a 37% increase in knowledge relative to baseline levels. Statistical analysis confirmed that the difference between pre- and post-training scores was highly significant ($t = 11.41$, $p < 0.001$) (Table 2).

Table 1. Descriptive Statistics of Pre- and Post-Training Motorcycle Safety Knowledge Scores

Assessment	N	Mean Score	Standard Deviation (SD)
Pre-Training Test	153	5.50	1.55
Post-Training Test	153	7.53	1.56

Table 2. Comparison of Pre- and Post-Training Motorcycle Safety Knowledge Scores

Variable	Mean difference	t-value	p-value	Significance
Post-test vs Pre-test	2.03	11.41	<0.001	Significant

The post-training assessment showed substantial improvements across all motorcycle safety knowledge topics. The most notable improvements were observed in braking technique and hazard recognition, which had the lowest baseline knowledge levels prior to the training. After the intervention, correct responses increased to 79% and 73%, respectively, indicating that hands-on exercises enabled participants to directly apply theoretical concepts, reinforcing learning through experiential practice. (Table 3).

Table 3. Selected Question-Level Performance

Knowledge Topic	Pre-Training Correct (%)	Post-Training Correct (%)
Worker responsibility under OSH legislation	62%	88%
Helmet safety knowledge	56%	86%
Causes of road crashes	76%	92%
Unsafe riding behaviour	99%	100%
Braking technique on dry roads	21%	79%
Hazard recognition	14%	73%

The findings suggest that participants improved their understanding of several key road safety concepts, including hazard recognition, safe riding behaviour, braking techniques and crash causation factors. These improvements demonstrate that targeted educational interventions can effectively address motorcycle safety knowledge gaps among motorcycle commuters.

Benefits to road safety

This study provides evidence that structured workplace motorcycle safety training can significantly improve workers' knowledge of safe riding practices and road hazard awareness. By addressing critical knowledge gaps, the training programme supports safer riding behaviour among workers who rely on motorcycles for daily commuting. Improved motorcycle safety knowledge may increase riders' awareness of safe riding practices and hazard perception, which have been associated with safer riding behaviour in previous studies. Integrating such initiatives into organisational safety programmes allows employers to play an active role in promoting safer commuting practices among employees. This approach also aligns with the principles of the Safe System approach by strengthening the safer road users pillar and promoting shared responsibility between organisations, road users, and policymakers in preventing road traffic injuries. Ultimately, the implementation of evidence-based motorcycle safety education programmes in workplaces has the potential to contribute to long-term reductions in motorcycle-related crashes, injuries, and fatalities.

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Implications for policy and/or practice

The results show that targeted post-training interventions significantly improved correct knowledge and response behaviors among road users, indicating that structured education can improve knowledge related to safe riding practices, providing an important foundation for future behavioural change.

Policy Implications: Mandating regular, standardized training for drivers and traffic personnel, particularly focused on high-risk scenarios identified in this study, can enhance safety outcomes. Incentives for adopting evidence-based behavioral interventions in licensing and professional development frameworks are recommended.

Practice Implications: Employers, occupational safety professionals and road safety training providers should implement scenario-based simulations and refresher modules, to reinforce learning and support safer riding decisions. Public awareness campaigns should target behavioral factors most responsive to training, ensuring interventions are both effective and focused.

By integrating these evidence-based measures into policy and practice, trauma from road crashes can be systematically reduced, contributing to safer roads and improved public health outcomes.

Limitations

The study used a single-group pre–post design without a control group, limiting the ability to attribute improvements solely to the training intervention. Testing effects, short-term recall, and other uncontrolled factors may have contributed to the observed improvements. In addition, the study assessed immediate knowledge gain rather than long-term knowledge retention, behavioural change, or crash outcomes.

Conclusions

This study demonstrates that structured workplace motorcycle safety training significantly improves motorcycle safety knowledge among employees who commute by motorcycle. Although the findings support the educational value of workplace road safety programmes, the single-group pre–post design without a comparison group limits causal inference, and improvements may partly reflect testing effects or short-term knowledge retention. Furthermore, this study measured knowledge outcomes rather than behavioural change or crash reduction. Future research should examine long-term knowledge retention, riding behaviour, and crash outcomes using controlled study designs across multiple workplaces.

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DRAFT

Simulating the impact of road safety interventions with system dynamics

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Abstract
Whilst it is acknowledged that there are many systemic and societal factors that contribute to road trauma, there is little research exploring the potential impact of interventions that target such factors. This abstract presents the findings from a study that involved the use of the Causal Loop Diagram (CLD) and System Dynamics (SD) methods to develop models of road trauma in Queensland, Australia and simulate the likely impact of nine road safety interventions. The CLD demonstrates the influence that societal issues (e.g., health, drug and alcohol misuse, work pressures) and factors such as urban sprawl and vehicle dependency have on road trauma. The SD model simulations demonstrate that from the interventions tested, an integrated suite of interventions comprising enforcement, speed management, mode shift, land use planning and initiatives targeting societal health and work pressures will likely provide the greatest reduction in crashes, serious injuries and fatalities by 2050. The implications for road safety are discussed.

Introduction
There is a growing body of work using systems thinking methods to better understand the complex systemic causes of road trauma. This research has revealed the inherent complexity of road transport systems and has demonstrated that there are often complex networks of variables underpinning road trauma (e.g., Salmon et al., 2019; 2020). Although some of these variables relate to individual road users (e.g. experience, risk tolerance, complacency, impairment), others reside elsewhere in road transport systems (e.g., road design, road safety culture), and more broadly across society (e.g., drug and alcohol dependence). This body of work suggests that, though road users engage in behaviours that play a direct causal role in road crashes and trauma, a range of variables across road transport and society interact to influence these behaviours (Salmon et al., 2020).

Whilst this work is beginning to gain traction in road safety research and practice, few studies have sought to explore the identification and evaluation of novel interventions derived from systems thinking-based analyses. As a result, though road safety practitioners are keen to translate systems thinking-based research, there is little information available to support policy decision making regarding novel interventions and their likely effectiveness. This paper describes the findings from a study that involved the use of two systems thinking methods, Causal Loop Diagrams (CLD) and System Dynamics (SD) to develop qualitative and quantitative models of road trauma in Queensland, Australia that could be used to identify novel interventions and simulate their likely impact on serious injury crashes between now and 2050.

Conference theme
This work addresses the ARSC2026 conference theme *From Evidence to Action: Shaping a Brighter Future* as it provides evidence to support policy decision making around the actions required to enhance road trauma prevention.

Method
The first phase of the study involved the development of a CLD describing the variables that interact to create road trauma in Queensland, Australia. CLD is a method that is used to elicit and represent stakeholder perspectives on the positive and negative feedback loops that interact to dynamically to influence system behaviour. Initially, the research team developed a draft CLD of road trauma based on existing research literature, publicly available crash data, and existing systems analyses undertaken by the authors (e.g., McClure et al., 2015; Salmon et al., 2019; 2020). The boundary for the model was set as the causes of road trauma in Queensland, Australia involving all forms of road user (e.g., vehicle drivers, motorcyclists, pedestrians, cyclists, personal mobility device users). The draft CLD was then reviewed and refined during a subject matter expert workshop involving 18 road safety stakeholders (9 male, 9 female; age 47.3 ± 5.9 yrs).

The second phase involved the development of a quantitative computational SD model of serious injury and fatal

crashes in Queensland based on the CLD. SD is a computational modelling method that is used to simulate the behaviour of complex systems over time. The SD model was first drafted by the project team and then reviewed by road safety and public health stakeholders in a second group modelling workshop. An additional component of the workshop involved consultation with participants to identify a set of candidate interventions that could be simulated via the SD model. The following interventions were identified:

1. Enforcement to increase perceived risk and compliance
2. Education campaigns to influence driver behaviour
3. Speed management
4. Mode shifts to promote safer transport choices
5. Land use planning and urban design to reduce the likelihood of serious injuries and fatalities (e.g., more pedestrian and bicycle lanes, round abouts)
6. Societal health and work pressure initiatives to reduce stress and fatigue-related risks
7. Combination of Intervention 1 (Enforcement), 2 (Education), and 3 (Speed management)
8. Combination of Intervention 1 (Enforcement), 2 (Education) with an enhance impact of speed management
9. Combination of interventions 1 (Enforcement), 3 (Speed management), 4 (Modal shift), 5 (Land use planning) and 6 (Societal health and work pressure initiatives).

Post-workshop, the SD model was validated through simulation and refinement until key outcome variables, including the total number of crashes, serious injuries and fatalities, were found to closely track historical trends observed in the real-world road safety data. The final SD model was then used to simulate the likely impacts of the candidate interventions on the annual number of serious injury and fatal crashes between now and 2050.

Results

Causal Loop Diagram

The full CLD includes 36 variables which can be grouped into the following five categories: societal issues (e.g., societal health, drug and alcohol misuse, work pressures), reliance on personal vehicles (e.g., dependency on personal vehicles, availability of public transport services), road user exposure and behaviour (e.g., exposure for different road users, speeding, distraction, impairment), road safety outcomes (e.g., unsafe interactions, crashes, injuries and fatalities), and the road safety response (e.g., recognition of problem, political will, road safety education and awareness, enforcement). A summary causal map based on these five categories is presented in Figure 1. The arrows between the groups of variables included in Figure 1 show the dynamic relationship between them. For example, Figure 1 shows that, as societal issues such as drug and alcohol misuse and work pressures increase, more road users engage in behaviours such as speeding or driving whilst impaired, which in turn results in an increase in unsafe interactions, crashes, and injuries and fatalities.

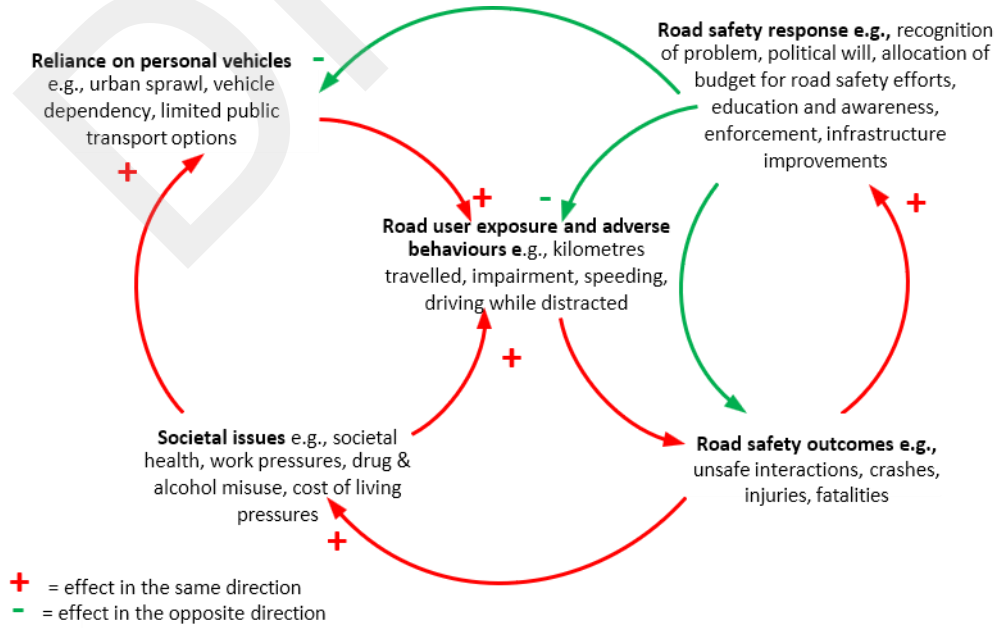

Figure 1. Simplified causal map of road trauma in Queensland.

System Dynamics model

Figure 2 presents the structure of the SD model of serious injury and fatal crashes in Queensland. The final SD model comprises nine interrelated sectors representing nine distinct groups of contributory factors identified in the CLD.

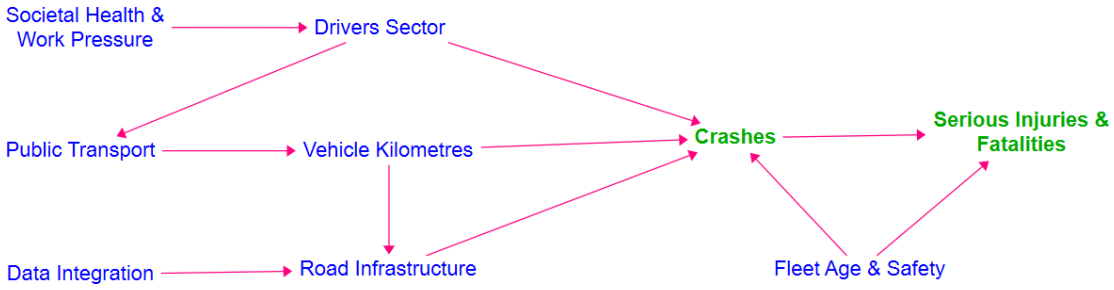

Figure 2. Overview of serious injury and fatal crashes in Queensland SD model sectors

The simulations showed the greatest effect in terms of reductions in crashes, serious injuries, and fatalities was found when interventions were combined. Specifically, the combined intervention comprising enforcement, speed management, mode shift, land use planning and societal health and work pressure initiatives (Intervention 9) created a reduction of approximately 27% in crashes, serious injuries and fatalities by 2050. The next most effective was an intervention comprising enforcement, education, and speed management (Intervention 7) which produced a 22% reduction in crashes, serious injuries, and fatalities by 2050. The combined enforcement, education, and speed management intervention was further tested with a modification to model assumptions around the effectiveness of speed management (from 20% to 40%) and enforcement (from 40% to 50%).

According to the simulations this intervention was the most effective, creating a reduction of crashes, serious injuries, and fatalities of approximately 40% by 2050.

Benefits to road safety

This work has two primary benefits for road safety. First, the qualitative CLD provides a comprehensive overview of the variables that interact to create road trauma. The model therefore supports road safety practitioners and policy makers in identifying areas that could be targeted by intervention and in developing novel interventions to supplement current road safety efforts. Second, the quantitative SD model provides a basis for simulating the likely impacts of different interventions. This provides support to policy decision makers when selecting interventions and developing road safety strategy.

Implications for policy and/or practice

The findings suggest that combined strategies that target road user behaviour, road user exposure, and societal health issues will likely be most beneficial in terms of reducing crashes, serious injuries, and fatalities. This finding aligns with other research that has recommended integrated approaches to road safety interventions (e.g., Cox et al., 2026; McClure et al., 2015; Salmon et al., 2020). The findings also indicate that enhancing the effectiveness of speed management and enforcement will support a significant reduction road crashes, serious injuries, and fatalities. It is therefore recommended that efforts designed to enhance the effectiveness of speed management and enforcement are undertaken and are also included in new road safety action plans.

Conclusions

This study has added to the growing consensus that road trauma is created by a complex set of interacting feedback loops that span road users, road transport systems, and society more broadly. Whilst many of these factors reside within the road transport system, wider societal issues outside the control of road safety practitioners have a key influence on driver behaviour and road safety outcomes. Consideration of these societal issues and influences is strongly urged when developing road safety strategy, policy, and interventions. It is concluded that road safety interventions that target both road user behaviour, road user exposure, and societal health issues will be most effective in reducing the road toll.

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Fatalistic beliefs and pedestrian risk perception and behaviour in Ghana

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Abstract
Global traffic safety reports indicate that pedestrians account for a significant share of road traffic deaths and injuries. Beyond infrastructure and policies, human factors such as fatalistic traffic beliefs and cultural superstitions also influence pedestrian safety. Understanding these psychological and cultural factors is essential for creating effective safety campaigns and behavioural interventions. Through moderation analysis, this study sought to determine whether the link between pedestrians' risk perception and safe walking behaviour varies across different levels of fatalistic traffic beliefs. The study found that risk perception positively affects safe walking behaviour. Fatalistic traffic beliefs also positively impact safe walking behaviour. However, the interaction between risk perception and fatalistic traffic beliefs was negative and statistically significant, indicating that fatalistic traffic beliefs diminish the influence of risk perception on safe walking behaviour. The findings suggest that pedestrian safety efforts might be improved by segmenting audiences based on levels of fatalism or related beliefs.

Introduction
Road traffic collisions are shaped by a combination of infrastructural, environmental, and human factors, with pedestrian behaviour playing a critical role in safety outcomes. Beyond observable actions, pedestrians' attitudes, beliefs, and perceptions strongly influence how they navigate traffic environments. In many low- and middle-income countries, cultural beliefs and superstitions, particularly fatalistic beliefs about divine control, luck, and predestination, shape perceptions of risk and responsibility (Acela et al., 2025; Kayani et al., 2011; Liu et al., 2021). Risk perception is a key determinant of safety behaviour (Rosenstock et al., 1988), with higher perceived risk generally associated with safer walking practices. However, risk perception itself is shaped by socio-cultural, environmental, demographic, and psychological factors.

Empirical studies show that fatalistic beliefs influence pedestrian behaviour, although effects vary across contexts. McIlroy et al. (2020) found that stronger fatalistic beliefs were generally associated with riskier pedestrian behaviour across six countries, but belief in divine control was associated with safer behaviour in Bangladesh and Kenya, whereas it was associated with increased risk-taking in China, Thailand, and Vietnam. In China, Liu et al. (2021) reported that fatalistic beliefs and road safety attitudes significantly predicted pedestrian behaviour, whereas risk perception showed no direct association with risky behaviour, highlighting the need to examine interaction effects. Similarly, McIlroy et al. (2022) demonstrated that fatalistic beliefs influenced road safety attitudes both directly and indirectly through reduced risk perception in Brazil and Ecuador.

Cultural norms also shape pedestrian decision-making. Pelé et al. (2017) found that collectivist norms in Japan encouraged rule compliance, whereas more individualistic norms in France were associated with higher rates of unsafe crossings. In Ghana, Amponsah-Tawiah (2018) reported that belief in spiritual protection reduced adherence to safety practices, whereas earlier studies in South Africa and Côte d'Ivoire linked fatalism to less cautious safety behaviour (Deery, 1999; Kouabenan, 1998, cited in Liu et al., 2021).

Although safety concerns strongly influence walking decisions (Handy et al., 2006; Hong & Chen, 2014, cited in Zhang & Bandara, 2024), and distraction is increasingly recognised as a risk factor (Sam et al., 2023), the socio-cultural dimensions of pedestrian safety remain underexplored in Ghana. Fatalistic beliefs, which reflect perceptions of limited personal control over events (Ngueutsa & Kouabenan, 2017), are consistently associated with lower perceived risk and riskier traffic behaviour (Kayani et al., 2011; Nævestad et al., 2025). This study addresses this gap by examining whether fatalistic traffic beliefs (i.e., the tendency to perceive life events as predestined and unavoidable) moderate the relationship between risk perception and safe walking behaviour among pedestrians in Ghana, thereby contributing context-specific evidence to support culturally responsive road safety interventions.

Conference theme

This study directly addresses the ARSC 2026 theme by generating context-specific evidence on how fatalistic traffic beliefs shape pedestrian risk perception and behaviour in Ghana, thereby supporting the design of culturally responsive pedestrian safety interventions that translate research evidence into practical action to reduce injuries and improve road safety.

Method

The study employed a simple moderation framework to determine whether the relationship between pedestrians' risk perception (independent variable) and safe walking behaviour (dependent variable) varies across levels of fatalistic traffic beliefs (moderator). The model used Hayes PROCESS v4.2 (Model 1) in SPSS version 29, with the interaction term (Y*X) as the focus of the moderation analysis (Hayes, 2022). Data were collected from 1,060 respondents (pedestrians) in Accra (n = 516) and Kumasi (n = 544) in Ghana via KoboToolbox across five high-risk, fatal-crash corridors in each city. Accra and Kumasi, Ghana's two most urbanised cities, experience high traffic volumes due to their commercial importance and activities and are recognised as Ghana's top two crash hotspots, with a high number of pedestrian crashes each year. Fatalistic traffic beliefs (7 items; e.g., "each man's fate is predetermined, and it is very difficult to prevent a road crash from occurring"), risk perception (7 items, e.g., "making or receiving phone calls while crossing the road), and safe walking behaviour (5 items, e.g., "I usually follow the pedestrian traffic signals, not walking through a red light") were measured on a 5-point scale. The construct items were explicitly tailored to pedestrian or walking contexts, drawing on anecdotal evidence from the two cities to ensure valid responses.

Results

The study found significant relationships among the measures used. Risk perception was negatively associated with fatalistic traffic beliefs ($r = -0.07$, $p < 0.05$) but positively associated with safe walking behaviour ($r = 0.10$, $p < 0.001$). Additionally, fatalistic traffic beliefs were positively related to safe walking behaviour ($r = .10$, $p < .001$). This finding suggests that the higher a respondent's fatalistic beliefs, the lower the perceived risk, and the higher the perceived risk, the more cautious the walking behaviour in traffic. A greater perceived traffic risk generally prompts pedestrians to be more cautious. Furthermore, we found that fatalistic traffic beliefs were positively linked to safe walking behaviour. The study further examined how respondents' fatalistic traffic beliefs influence their perceived risks and walking behaviours, using a moderation analysis with centred variables. The model explained 3.3% of the variance in safe walking behaviour, $R^2 = 0.033$, $F(3, 1052) = 8.442$, $p < .001$. Risk perception ($M = 31.1$, $SD = 4.4$) positively influenced safe walking behaviour ($b = .09$, $t(1052) = 3.61$, $p < .001$). Fatalistic traffic beliefs also positively affected safe walking behaviour ($b = .05$, $t(1052) = 4.12$, $p < .001$). Furthermore, the interaction between risk perception and fatalistic traffic beliefs was negative and statistically significant ($b = -.01$, $t(1052) = -3.24$, $p = .001$), indicating that fatalistic traffic beliefs negatively moderated the effect of respondents' risk perception on safe walking behaviour. Figure 1 shows that a significant relationship exists between risk perception and safe walking behaviour when respondents' fatalistic traffic beliefs are low ($b = 0.173$, 95% CI [0.09, 0.26], $t = 4.096$, $p = 0.000$) or at an average level ($b = 0.094$, 95% CI [0.04, 0.15], $t = 3.614$, $p = 0.000$). However, this relationship is not evident at high levels. Therefore, the significant relationship between risk perception and safe walking behaviour appears to be limited to respondents with low or average levels of fatalistic traffic beliefs. Lower fatalistic beliefs strengthened the influence of risk perception on compliance (safe walking behaviour).

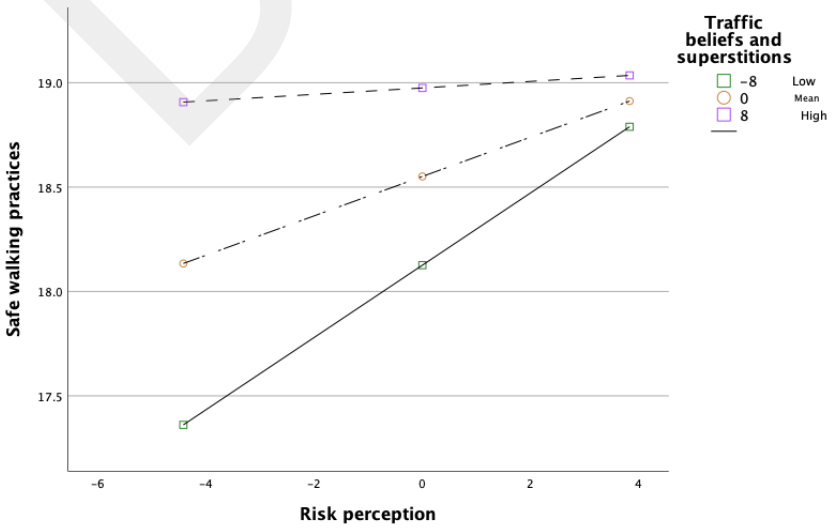

Figure 1. Interactional effect of fatalistic traffic beliefs on the relationship between risk perception and safe walking behaviour

Benefits to road safety

This work contributes to improved road safety outcomes by identifying how fatalistic traffic beliefs shape pedestrians' risk perception and walking behaviour, which is often overlooked in conventional safety interventions. By showing when and how risk awareness translates into safer behaviour, the study supports more effective targeting of pedestrian education, risk communication, and behaviour-change campaigns, helping practitioners design culturally grounded interventions that reduce risky pedestrian behaviour, improve compliance with safety practices, and thereby lower pedestrian injuries and fatalities in high-risk urban environments.

Implications for policy and/or practice

The findings have significant implications for pedestrian safety policy and intervention design. Initially, risk-focused safety campaigns should be complemented by approaches that enhance perceived personal control. Messaging that only highlights traffic dangers may raise risk awareness or fear, but will likely have minimal influence on behaviour if fatalistic attitudes are prevalent. Interventions need to clearly link pedestrian behaviours, such as using designated crossings or avoiding distractions, to improved safety outcomes.

Pedestrian safety education programmes should incorporate behavioural and cognitive elements to challenge misconceptions about fate, control, and risk. Training that enhances decision-making skills, such as gap assessment and hazard anticipation, can reinforce the idea that individual actions can significantly affect outcomes, thereby strengthening the link between risk perception and behaviour. This suggests that pedestrians' fatalistic beliefs could be addressed through culturally focused education and interventions.

Furthermore, the findings indicate that pedestrian safety measures could be more effective if tailored to audience segments defined by levels of fatalism or similar belief orientations. It may be essential to develop targeted strategies for groups with high fatalism, as they tend to be less receptive to standard risk-awareness messages.

Conclusions

The study indicates that fatalistic traffic beliefs affect risk perception and safe walking behaviour, both directly and indirectly. Specifically, the link between risk perception and safe walking behaviour is influenced by the level of fatalistic beliefs: it is significant when these beliefs are low or moderate, but not when they are high.
Our study shows that simply perceiving risk isn't enough to encourage safe pedestrian behaviour, particularly in contexts where fatalistic and cultural beliefs are prevalent.

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The role of affect heuristics in drug driving

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Abstract
Drug driving persists despite expanded enforcement, with high rates of recidivism and polysubstance use amongst detected drivers. This cross-sectional survey (N = 792; 77% male, 21% female, 2% non-binary/other; M age = 47.48, SD = 14.93) examines whether affect heuristic processing, where emotional responses guide decision making, can help explain this phenomenon. Affective evaluations were compared across general drivers, polysubstance users, single-substance users, and prescribed cannabis users. Drug drivers perceived drug driving as more beneficial, less certainty of apprehension, and less severe punishment than abstainers, with patterns indistinguishable across substance types, suggesting the act of drug driving, rather than the drug type, influences affective processing. Prescribed cannabis users who refrained from drug driving perceived greater certainty of apprehension and safety of drug driving compared to non-drug users, but similar perceived benefits, suggesting compliance may be supported by cognitive deterrence appraisals rather than reduced positive affect. Findings indicate interventions may benefit from targeting emotional associations underlying drug driving behaviour rather than relying solely on cognitive deterrence messaging.

Introduction
Drug driving is a critical road safety concern both internationally and in Australia. From 2015 - 2020, Queensland Police conducted 302,211 roadside drug tests, detecting 60,551 positive results, a detection rate of 20% (Mills et al., 2021). Polysubstance use, where drivers combine multiple impairing substances, comprised 27% of detections, with methamphetamine-cannabis combinations particularly prevalent (Mills et al., 2021). Despite enforcement expansion, recidivism rates remain high, with 25% of detected drivers being repeat offenders, with some drivers apprehended up to 11 times (Mills et al., 2022).

Traditional deterrence theory assumes individuals make rational cost-benefit calculations when deciding whether to offend, weighing perceived benefits against the certainty, severity, and celerity of potential sanctions (Becker, 1968). However, the affect heuristic framework offers an alternative perspective, where risk decisions are guided by emotional responses rather than cognitive assessments. When something evokes positive feelings, its benefits are judged high and risks low; conversely, negative feelings lead to perceptions of high risk with low benefit (Finucane et al., 2000). This emotional processing often operates automatically and unconsciously, making it resistant to interventions that predominantly focus on cognitive processing.

This study examines whether affective evaluations of drug driving differ across the distinct driver subpopulations of general drivers, polysubstance users, single-substance users, and prescribed cannabis users. Understanding these differences may reveal why traditional enforcement has limited deterrent effects for certain subpopulations. Such insights are beneficial for developing interventions that address the drug driving problem beyond traditional deterrence approaches.

Conference theme
This research addresses the ARSC 2026 theme 'From Evidence to Action: Shaping a Brighter Future' by examining the psychological mechanisms that underlie drug driving decisions. A challenge threatening the efficacy of road safety interventions is the assumption that road users engage in rational decision-making, upon which traditional enforcement approaches have generally been designed. The evidence reveals limitations in these approaches for certain subpopulations, demonstrating that affective processing and cognitive biases may override rational deliberation in drug driving decision-making. Theoretical doctrines such as deterrence theory that underpin enforcement countermeasures should incorporate cognitive biases instead of relying on the assumption that drivers are always thinking rationally. These findings offer a foundation for future research exploring how affective processing interacts with deterrence mechanisms across broader populations and offence types. The path to a brighter road safety future may be supported by initiatives that interrupt the emotional heuristic associations supporting drug driving behaviours, and this research offers evidence from which such strategies can be developed and evaluated.

Method
Licenced Queensland drivers aged 18 and older (N = 792) were recruited between March and May 2025 through targeted Facebook and Instagram advertisements. Participants completed a 20-minute online questionnaire assessing demographic information, drug use and driving behaviours, and affect heuristic evaluations of drug driving, including perceived certainty of apprehension, benefits, and punishment severity. Participants were categorised into comparison

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groups: drug users who had used drugs at least once in the last 12 months (n = 380), and drivers who did not use drugs (n = 412). Subgroup analyses examined polysubstance users (n = 130), single-substance users (n = 27), and prescribed cannabis users (n =160). The polysubstance user group (n = 130) included 75 participants who were originally prescribed cannabis users but reported concurrent use of additional substances and were therefore recategorised into this group. These 75 participants are represented in the polysubstance group only. Independent samples t-tests compared affective evaluations between drug drivers and non-drug drivers, and one-way ANOVA analyses examined differences among driver subgroups.

Results

Table 1 presents participant demographic information (N = 792) and Table 2 presents drug use within four hours prior to driving among drug drivers (n = 233). Together, these tables provide a comprehensive profile of the sample, including licence type, weekly driving hours, and patterns of substance use prior to driving. All construct composite scores demonstrated good to excellent internal consistency. Perceived certainty of apprehension and perceived benefit of drug driving showed a small but statistically significant positive correlation (r = .07, p < .05), while the two punishment severity items were moderately correlated (r = .50, p < .01).

Table 1. Participant Demographic Information (N = 792)

Demographic Item	Responses	%
Age	18-89 years (M = 47.48, SD = 14.93)	
Gender	Males: n = 610 Female: n = 168 Other/Prefer not to say: n = 14	77.00 21.20 1.80
Licence type	Open: n = 725 P2: n = 36 P1: n = 14 Learner: n = 5 Suspended/disqualified: n = 12	91.50 4.50 1.80 0.60 1.50
Hours driving per week	Range 0 – 100 (M = 14.89, SD = 13.87)	
Prescribed cannabis	Yes: n = 235 No: n = 167 Missing: n= 390	29.70 21.10 49.20

Table 2. All Participants' Drug Use Within Four Hours Prior to Driving (N = 233)

Drug type	***M(SD)*** Range value = 5-25	**Never *n* (%)** Value = 1	**Once or a few times *n* (%)** Value = 2	**Monthly *n* (%)** Value = 3	**Weekly *n* (%)** Value = 4	**Daily/almost daily *n* (%)** Value = 5
Cannabis	3.60(1.45)	17(2.10)	65(8.20)	10(1.30)	42(5.30)	98(12.40)
Ice or speed	1.28(0.88)	202(25.50)	12(1.50)	3(0.40)	3(0.40)	9(1.10)
Ecstasy	1.06(0.27)	218(27.50)	10(1.30)	2(0.30)	0(0)	0(0)
Cocaine	1.12(0.41)	202(25.50)	22(2.80)	1(0.1)	0(0)	1(0.1)
Heroin	1.04(0.30)	220(27.80)	4(0.50)	0(0)	0(0)	1(0.10)
Psychedelics	1.06(0.33)	214(27.00)	10(1.30)	0(0)	0(0)	1(0.10)
Prescription opioids	1.41(0.93)	175(22.10)	27(3.40)	9(1.10)	6(0.80)	7(0.90)
Other drugs	1.12(0.53)	181(22.80)	8(1.00)	2(0.30)	1(0.10)	2(0.30)

Note. Higher range value indicates higher drug consumption frequency.

Drivers Who consume Drugs vs Drivers That Do Not Consume Drugs

Among all participants (N = 792), independent samples t-tests revealed drug users (n = 412) reported more positive affect heuristic evaluations than non-drug users (n = 380), perceiving drug driving as significantly more beneficial (g=0.75, p < .001), and with higher certainty of apprehension (g=0.26, p < .001), representing large and moderate effect sizes, respectively. No significant differences emerged in perceived severity of punishment for receiving a fine or loss of licence between drivers that consumed drugs and drivers who did not.

Comparisons Between Drug Users Only

Within the prescribed cannabis group (n = 160), independent samples t-tests revealed that prescribed cannabis users who drove after drug use (n = 76) reported more positive affect heuristic evaluations of safety than prescribed cannabis users who refrained from driving (n = 84), with a reversed pattern for apprehension certainty and severity. Specifically, prescribed cannabis who drove within four hours of drug consumption, when compared to prescribed cannabis users who refrained from driving after drug use, perceived significantly lower risk of being caught (g = -0.47, p = .003),

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perceived fines as significantly less severe (g = -0.43, p = .009), while simultaneously perceiving drug driving as significantly more beneficial (g = 1.06, p < .001). No significant difference between these two prescribed cannabis groups was found for perceived severity of loss of licence (g = -0.12, p = .442). Across all drug driver groups, a one-way ANOVA comparing polysubstance, single-substance, and prescribed cannabis drug drivers revealed no significant differences in perceived certainty of apprehension (F[2, 230] = 1.50, p = .225, η^2 = .013), perceived benefits (F[2, 230] = 0.95, p = .389, η^2 = .008), or perceived severity of punishment (fine: F[2, 230] = 0.10, p = .908, η^2 = .001; licence: F[2, 230] = 0.83, p = .437, η^2 = .007), suggesting the act of drug driving itself, rather than substance type, influences affective processing.

Comparisons of Drivers that Abstain from Drug Driving

Among drivers who did not drive within four hours of drug use, independent samples t-tests revealed that prescribed cannabis non-drivers (n = 84) perceived significantly greater certainty of apprehension than drivers who did not use drugs (n = 380; g = -0.64, p < .001; M = 4.69, SD = 1.33 vs. M = 3.74, SD = 1.52). Prescribed cannabis non-drivers also perceived fines for drug driving as significantly more severe than drivers who did not use drugs (g = -0.44, p < .001; M = 6.31, SD = 1.26 vs. M = 5.58, SD = 1.75), as well as loss of licence (g = -0.27, p = .008; M = 6.61, SD = 0.99 vs. M = 6.26, SD = 1.37). Prescribed cannabis non-drivers also perceived drug driving as significantly safer than drivers who did not use drugs (g = -0.32, p = .004; M = 2.85, SD = 1.34 vs. M = 2.35, SD = 1.60). No significant differences between prescribed cannabis non-drivers and drivers who did not use drugs were found for perceived benefits of drug driving. This pattern of heightened deterrence perceptions across certainty of apprehension and punishment severity, alongside greater perceived safety of drug driving but comparable perceived benefits, suggests that compliance among prescribed cannabis non-drivers may be driven primarily by stronger deterrence appraisals rather than reduced motivation to drug drive.

Benefits to road safety

This research reveals that drug drivers perceived drug driving as more beneficial than abstainers, whilst also perceiving lower detection risk and less severe punishment. Understanding these affective patterns may help explain why current enforcement strategies have limited effectiveness in reducing recidivism. By demonstrating similar patterns across substance types, this research suggests that unified initiatives targeting affective processing could enhance current approaches to drug driving enforcement.

Implications for policy and/or practice

Findings challenge enforcement strategies relying solely on increased detection certainty or penalty severity. When positive affect towards drug driving remain unchanged, traditional deterrence mechanisms may have limited effectiveness. Initiatives could target affective evaluations directly, using approaches that engage emotional processing rather than assuming rational cognitive assessment. Homogeneity across substance types enables simplified intervention design, allowing for standardised messaging across all drug driver populations. For prescribed cannabis users specifically, heightened detection awareness without corresponding affective change suggests cognitive pathways to compliance may be leveraged through clear medical warnings and prescription guidelines.

Conclusions

Drug drivers uniformly demonstrated more positive affective evaluations of drug driving than abstainers across all substance types. Notably, prescribed cannabis users who refrained from drug driving demonstrated heightened detection awareness without corresponding differences in perceived benefits, suggesting that compliance in this subgroup may operate through cognitive rather than affective pathways. This homogeneity across drug driver groups suggests that engaging in drug driving influences affective processing more distinctly than the specific substances used. When emotional processing dominates decision-making, initiatives targeting affective evaluations may prove valuable for enhancing traditional enforcement approaches. Future research should explore how affective evaluations can be modified directly rather than relying solely on deterrence initiatives. These findings highlight the need for psychologically grounded enforcement strategies that recognise how different subpopulations process risk information when deciding whether to engage in or abstain from drug driving.

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Mapping risk in WA young drivers: DBQ Meets BYNDS

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Abstract
Young novice drivers are disproportionately represented in road crashes, with risky driving behaviour a key contributor. Accurate measurement of these behaviours is critical for informing prevention strategies. The Driver Behaviour Questionnaire (DBQ) is widely used; however, its suitability for Australian young drivers has been questioned. The Behaviour of Young Novice Driver Survey (BYNDS) was developed to capture developmentally relevant risk patterns. This study examined the psychometric performance of the DBQ and BYNDS in a Western Australian young driver sample. Exploratory and confirmatory factor analyses were conducted, followed by structural equation modelling to assess relationships with crash involvement. The DBQ demonstrated acceptable factor loadings but weak convergent and discriminant validity, limiting its suitability for structural modelling. In contrast, the BYNDS showed strong construct validity and supported structural modelling despite mixed incremental fit indices. Findings suggest the BYNDS provides a more robust framework for understanding and addressing risky driving among young drivers.

Background
Young novice drivers aged 15–24 are consistently overrepresented in road crashes, accounting for around a quarter of fatalities despite representing only 10–15% of licence holders (Department of Infrastructure Transport Regional Development Communications and the Arts, 2024). In Western Australia, young drivers aged 17–19 recorded the highest KSI rate in 2024 (103 per 100,000), nearly double the population average (54 per 100,000) (Road Safety Commission, 2025). Risky behaviours such as speeding, rule violations, drug and alcohol impairment, and distraction are known key contributors to this elevated risk (Curry et al., 2015; Simons-Morton, 2011).

The Driver Behaviour Questionnaire (DBQ) was originally developed with a broad driver sample in Manchester, England (Reason et al., 1990). It is widely used to assess aberrant driving behaviours and crash risk; however, its suitability for Australian young drivers (as well as older drivers) has been questioned relative to adult cohorts (Stephens & Fitzharris, 2016). The Behaviour of Young Novice Driver Survey (BYNDS) was developed to include wider behavioural risks than the DBQ, and was found to capture distinct constructs that demonstrate stronger internal consistency (Scott-Parker et al., 2010). However, despite being well-validated, the BYNDS was limited to Queensland young drivers.

To assess its suitability to the WA population, the current study evaluated the psychometric performance of the BYNDS in a Western Australian young driver sample and directly compared its measurement and predictive validity with the DBQ. It was hypothesised that the structural equation model using the BYNDS as the measure of risky driving will demonstrate superior model fit and greater predictive validity for crash involvement compared to the SEM using the DBQ, reflecting its stronger conceptual alignment with young driver behaviour.

Conference theme
By examining how risky driving is best measured by young driver self-report questionnaires, this study supports the translation of research into action. Identifying more developmentally appropriate measures enables clearer identification of risk, to inform more effective intervention design, and stronger communication of road safety needs and priorities to policymakers and the community, including young novice drivers and their families..

Method
The study participants were first- and second-year psychology undergraduate students at The University of Western Australia (UWA), aged 17 to 25 years, and holding an independent car or motorcycle licence. Of a total of 342 responses, 288 surveys met the criteria and had sufficient data. The study was advertised on an internal online survey platform offering research training by including a debrief form about the study once completed (for which students received a half-point credit for taking part). The survey included demographic and driving experience items, prior crash involvement questions, and the driver behaviour questionnaires (DBQ and BYNDS); as well as several other validated psychological measures of interest[1] [2][3].

[1] Depression, Anxiety and Stress Scale (DASS-21) measuring psychological distress.
[2] Scale of Protective Factors (SPF-24) measuring resilience.
[3] Peer Pressure Risky Driving Scale (PPRDS) measuring direct and indirect peer pressure.

An Australian version of the DBQ was used (Stephens & Fitzharris, 2016). It comprises four factors: Errors, Lapses, Violations and Aggressive Violations.

The BYNDS (Scott-Parker et al., 2010) is comprised of five factors: Misjudgement, Risky Driving Exposure, Driver Mood, Transient Rule Violations and Fixed Rule Violations.

The present analysis focuses on comparisons between the DBQ and BYNDS. An exploratory factor analysis (EFA), a confirmatory factor analysis (CFA), and structural equation modelling (SEM) were conducted using IBM SPSS AMOS.

Results

Descriptive Statistics

Participants were 29.5% male, 69.4% female, 0.7% non-binary, and 0.3% other; and had a mean age of 19.1 years (SD=1.54). The median age was 19.0 years, with a 95% CI [18.86, 19.36]. Most respondents (99.7%) held a valid driving licence. Five participants held a motorcycle licence. In total, 22.3% had prior crash experience.

Exploratory Factor Analysis

EFA indicated excellent sampling adequacy for both measures, with strong inter-item correlations supporting factorability (DBQ: KMO = .926, Bartlett's $\chi^2(378) = 3242.836$, $p < .001$; BYNDS: KMO = .930, Bartlett's $\chi^2(946) = 9136.225$, $p < .001$). The DBQ analysis extracted four components while the BYNDS produced five constructs (presented in Table 2), reflecting theoretically meaningful factor structures aligned with the factor structures reported in other Australian studies.

Confirmatory Factor Analysis

Three CFA models for the DBQ were sequentially tested following inadequate fit in earlier models. Further modifications were not pursued as they lacked theoretical justification and did not meaningfully improve construct validity. Results for the final model indicated weak construct validity, with all constructs failing to meet recommended convergent validity thresholds (AVE ≥ .50) despite generally acceptable factor loadings and model fit improvement. This pattern suggests limited shared variance among items, evidence of construct overlap, and potential multidimensionality, highlighting the need to reconsider the DBQ measurement framework.

In contrast, the BYNDS CFA findings demonstrated strong construct validity, with high factor loadings and AVE exceeding recommended thresholds across all constructs, alongside clear discriminant validity. Although χ^2/df and RMSEA indicated acceptable fit, incremental fit indices fell below recommended levels (refer to Hu and Bentler (1999) for recommended model fit indices), suggesting that while the measurement components were robust, aspects of the structural configuration may require refinement. As such, a second model of the BYNDS was developed. Tables 1 and 2 show the model fit indices and construct validities of the final models of the DBQ and BYNDS.

Table 1. Model Fit Indices of the DBQ (Model-3) and BYNDS (Model-2)

Measure	χ^2/df	CFI	TLI	RMSEA	NFI	Convergent Validity
DBQ	1.87	0.95	0.93	0.06	0.90	Below Threshold
BYNDS	2.74	0.91	0.89	0.08	0.86	Acceptable

Table 2. Construct Validity of DBQ (Model-3) and BYNDS (Model-2)

Measure	Construct	No. of Indicators	Standardised Loadings (range)	AVE (Convergent Validity ≥ .50)	Discriminant Validity
DBQ	Errors	6	0.59 – 0.79	0.46	Limited support
	Lapses	3	0.56 – 0.65	0.38	Not supported
	Violations	4	0.65 – 0.68	0.44	Limited support
	Aggressive Violations	3	0.60 – 0.79	0.47	Limited support
BYNDS	Misjudgement	5	0.72 – 0.86	0.60	Supported
	Risky Driving Exposure	5	0.78 – 0.89	0.68	Supported
	Driver Mood	3	0.85 – 0.88	0.74	Supported
	Transient Rule Violations	6	0.76 – 0.87	0.68	Supported
	Fixed Rule Violations	9	0.88 – 0.96	0.86	Supported

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Structural Equation Modelling

Given inadequate measurement performance in CFA, the DBQ was not progressed to structural modelling. SEM analyses were therefore conducted using the BYNDS only. The BYNDS-SEM demonstrated acceptable validity and improved model fit, supporting its utility as a framework for explaining risky driving and crash involvement among young novice drivers. Figure 1 shows the SEM of the BYNDS in explaining crash involvement.

Benefits to road safety

These findings highlight the importance of using developmentally appropriate measures of risky driving, with the BYNDS offering improved capacity to identify, understand, and address crash risk among young drivers. These findings are in line with previous findings that the DBQ factor structure was not found to appropriately measure risky behaviour for the young driver (17-25) age group, despite it being a well-validated measure.

Implications for policy

Future research evaluating driver behaviour of young drivers should either utilise the shortened DBQ version, or the BYNDS.

Conclusions

In conclusion, the BYNDS showed stronger predictive validity of prior crash involvement, and had stronger conceptual alignment with young driver behaviour compared to the DBQ.

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Child car restraint e-learning for professionals

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Abstract
Incorrectly fitted or misused child car restraints significantly increases the risk of serious injury or death for children in the event of a vehicle crash. Many staff of community organisations that transport children as part of their role, face barriers to accessing flexible, evidence-based training on safe child car restraint use. This project involved the development of a Child Car Restraint E-Learning for Professionals for community organisations in Victoria and New South Wales (NSW). The resource provides practical guidance on selecting, installing, adjusting, and using child restraints, as well as maintaining and replacing them. By translating evidence into actionable learning, the online learning resource supports professionals of community organisations to adopt and model best practice behaviours, promotes shared responsibility for road safety, and provides a scalable approach to improving child passenger safety and informing organisational policies and practices.

Background
Correctly fitted and used child restraints and booster seats play an important part in protecting children from serious injury and death in the event of a crash. To ensure that the maximum level of protection is provided for children when travelling in a vehicle, it is important that the child car restraint or booster seat they are travelling in is i) the right one for their size, ii) correctly installed in the vehicle, and iii) properly adjusted and fastened to fit the child on every trip.

The risk of life-threatening injuries has been shown to be 4-6 times greater when child car restraints are incorrectly fitted or used (Neuroscience Research Australia and Kidsafe, 2020). Despite this, data shows that approximately 90% of child car restraints are incorrectly installed or used in Victoria (Koppel et al., 2024).

Incorrectly fitted child car restraints pose a significant and preventable risk to Australian children travelling in vehicles. Addressing this issue requires not only supporting parents and carers but also strengthening the capability of staff within community organisations who are responsible for transporting children as part of their role, ensuring that child car restraints are installed and used correctly on every trip. This includes staff from child protection services, foster care agencies and migrant and settlement support services, many of whom work with children from culturally and linguistically diverse backgrounds. These organisations are often required to transport children of varying ages, sizes, and developmental stages on a daily basis. As a result, staff must have the knowledge and practical skills to select, install, and correctly use a broad range of child restraint types.

Professional development opportunities among community organisations play an important role in building this capability, equipping staff with the confidence and competence needed to make informed decisions about appropriate child car restraint selection and use. Accredited training programs such as CRFPIA301: Provide Information and Advice on Correct Child Car Restraint Use and 52862WA: Type 1 Child Car Restraint Fitting provide both theoretical knowledge and hands-on practical learning to support community organisation staff in safely transporting the children in their care.

Conference theme
The Child Car Restraint E-Learning for Professionals aligns closely with the theme ‘From Evidence to Action: Shaping a Brighter Future’ by translating evidence on safe child car restraint use into a practical, accessible training resource for community organisations. While the e-learning tool is adapted from an existing parent and carer e-learning resource, it reflects and complements the National Child Restraint Best Practice Guidelines- as a benchmark for best practice.

In particular, this project focuses on creating safe road users by empowering staff of community organisations with the skills and knowledge to choose, install, adjust, and use child car restraints correctly. The information and advice provided through the online resource enhances the capability of staff to model and demonstrate safe behaviours, both to colleagues and the families or clients they support. By converting evidence into learning and training, the project contributes to safer transport practices and supports a brighter, safer future for children.

Project description

This project was funded in 2024 following an application made under the Victorian Transport Accident Commission's Road Safety Grants Program and a separate NSW funder, to develop two Child Car Restraint E-Learning for Professionals resources, tailored specifically for Victoria and New South Wales. Each online resource provides practical education on selecting, installing, adjusting, and using child car restraints, along with guidance on storing, cleaning, maintaining, and replacing them. Both e-learning tools are informed by the National Child Restraint Best Practice Guidelines and tailored to the relevant laws and regulations in their respective states, including specific guidance on child car restraints in taxi and ride-share services.

The e-learning resources were designed to address the limited access to child car restraint training for under-resourced community organisations by offering an affordable, time-efficient tool that can be completed at the learner's convenience. The Child Car Restraint E-Learning for Professionals was adapted from the successful Child Car Restraint E-Learning for Parents & Carers, developed in 2021. The Victorian e-learning version was launched to community organisations in October 2025, while the NSW version recently completed its pilot and the collection of results from that phase.
Key community organisations that benefit from this e-learning resource include family support services, foster and kinship support care services, Aboriginal community-controlled organisations and child protection. Other organisations also include those working with vulnerable families who often visit homes and observe inadequate transport practices.

As part of the development of the e-learning resource, several key activities were undertaken, including:

- Development and implementation of two online e-learning resources for professionals in community organisations in Victoria and NSW. These resources provide both theoretical and practical education on child car restraint selection, installation, adjustment, use, maintenance, and replacement - addressing a critical knowledge gap in the sector.
- Pilot testing in NSW with key stakeholders to evaluate course design, user experience, content relevance, practical applicability and structure.
- The creation of a suite of instructional videos was produced to visually demonstrate correct techniques for installing, adjusting, and using child car restraints. The videos are also shared across other channels, including social media, email campaigns, and professional presentations, to extend reach and reinforce key messages.
- The launch of free access for under-resourced organisations in Victoria which allows eligible community organisations to complete the e-learning free of charge for the first year, supporting financially and time-constrained groups in meeting their child transport safety obligations
- The development of supporting resources including a digital resource pack to accompany the e-learning, providing participants with links to further road safety from a range of road safety organisations.

Community organisations are often under-resourced financially and time poor, which has led to areas such as child car restraint safety being managed on an ad hoc basis, with some staff receiving little to no training or education at all. The project delivers an accessible solution to improve child car restraint safety knowledge and practices across community organisations in Victoria and NSW, with the aim to reduce and prevent road trauma among Australian children.

Findings

Monitoring and evaluation of the project have been conducted through a combination of online survey data, user feedback, and ongoing engagement with community organisations. For the Victorian e-learning resource, a post-course survey is sent to assess changes in participants' knowledge, confidence, and practices in selecting, installing, adjusting, and using child car restraints. While the NSW e-learning resource has not yet launched, insights from the NSW pilot can be reported.

Several key insights have emerged from both the development of the e-learning resources for Victoria and NSW and the analysis of post-course evaluation surveys in Victoria from October 2025, including:

- Within six months of launch, 217 professionals from Victorian community organisations registered for the e-learning, with 50% having completed it in full.
- Survey results from Victoria showed that 100% of respondents found the e-learning resource useful, 95% agreed or strongly agreed they gained knowledge on selecting, fitting, adjusting, and using child car restraints, 90% felt confident educating others, and 98% reported they could apply what they learned in their day-to-day work.
- From the NSW pilot, over 90% of participants reported the e-learning was well structured and the content relevant to their professional role, with more than 90% agreeing or strongly agreeing that they now have a greater understanding of child car seat laws and safety issue.
- The e-learning resource provides an alternative for those who do not require in-depth, hands-on training, as offered in other in person education and accredited courses, or for staff seeking flexible learning due to time constraints that make attending in-person training challenging.

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These findings indicate that the e-learning resource is meeting a critical need for accessible, flexible, evidence-based training for professionals, supporting improvements in knowledge, confidence, and safe child transport practices across Victorian community organisations.

Benefits to road safety

The Child Car Restraint E-Learning for Professionals supports improvements in local road safety across communities in Victoria and NSW by providing community organisation staff with the knowledge and skills to select the correct child restraint based on a child's size and age, correctly install it in vehicles, and ensure it is properly used and adjusted on every trip.

The e-learning fosters shared responsibility for road safety, empowering staff to take ownership of child passenger safety within their organisations and communities. Participants can share their knowledge with colleagues, families, and clients, promoting a culture of shared responsibility and extending the program's benefits throughout the community. It also reflects best practice, incorporating guidance aligned with the National Child Restraint Best Practice Guidelines and offering evidence-based recommendations on safe selection, installation, and use. Staff gain the knowledge and confidence to model and demonstrate best practice behaviours.

Through these approaches, the e-learning resource translates evidence-based guidance into actionable learning, strengthening road safety culture and child passenger safety across Victoria and NSW.

Implications for policy and/or practice

The outcomes of the Child Car Restraint E-Learning for Professionals have important implications for reducing road trauma involving children. From a policy perspective, the findings support the development of guidelines encouraging community organisations that transport children to ensure staff are trained in the safe selection, installation, adjustment, and use of child restraints. Embedding this training as a standard expectation could strengthen compliance with national child restraint best practice guidelines and support broader road safety strategies. From a practice perspective, the e-learning resource provides a scalable tool that enables staff to model safe behaviours and reinforce organisational practices for child restraint use, maintenance, and replacement. By translating evidence into practical learning, the resource promotes consistent best practice and supports safer child transport practices.

Conclusions

The Child Car Restraint E-Learning for Professionals effectively improves knowledge, confidence, and safe practices among community organisation staff responsible for transporting children in their care. Participants can model and share best practice behaviours with colleagues, clients, and families, fostering shared responsibility and strengthening a culture of road safety. High uptake and positive feedback demonstrate the resource's accessibility and value. Future work could expand the tool to additional sectors and organisations.

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A framework for safer and performance-based road design

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Abstract
This project addresses the need for safer road design in Western Australia by exploring how AusRAP star ratings can be embedded into the planning and construction of state road infrastructure. Although Main Roads has star-rated the entire state road network, the application of these ratings as a proactive design tool is not yet defined. This work examines the safety performance of existing Main Roads mid-block and intersection road stereotypes and evaluates how key design features influence AusRAP star-rating outcomes. It identifies feasible 3- and 4-star design targets and assesses both the potential reduction in fatal and serious injuries and the cost implications associated with adopting star-rating-led design principles. The project also delivers a design guideline to help practitioners understand how design decisions affect safety performance. Together, these outputs provide a clear pathway for integrating star ratings into policy and design practice to support safer and more consistent road outcomes.

Introduction
Road trauma remains a transport challenge in Australia. Improving the safety performance of the state network requires a consistent, objective framework that can guide safer road planning and design. Main Roads has completed AusRAP star ratings across the entire state network, providing an evidence-based measure of the level of safety built into existing roads. These ratings evaluate more than 70 infrastructure attributes related to risk for motorists, motorcyclists, bicyclists, and pedestrians, offering a clear indication of the safety quality of different road environments.

Despite the availability of this network-wide star rating dataset, its application in design and construction practice is not yet thoroughly defined and refined communication or tools are not available for designers and project managers to utilise. This project was initiated to determine whether star ratings can be used as a primary design target, to understand how existing Western Australian Road stereotypes perform, and to identify the design elements with the greatest potential to reduce serious injuries and fatalities when incorporated into planning and construction processes.

Conference theme
This work directly supports the ARSC2026 theme From Evidence to Action: Shaping a Brighter Future by transforming network-wide AusRAP star rating evidence into a practical framework for safer road design and construction in Western Australia. Although Main Roads has already captured comprehensive star rating data across the state network, this evidence has not yet been fully activated as a design decision-making tool. The project bridges this gap by analysing the safety performance of existing road stereotypes, identifying design features that meaningfully improve star ratings, and developing clear, implementable guidance for practitioners.
By translating data into applied design targets, the project enables designers and policy makers to embed safety performance metrics from the earliest planning stages. This ensures that evidence-based safety outcomes can be systematically achieved, contributing to a safer, more consistent, and trauma-reducing road network for the future.

Method
The project follows a structured, sequential, and evidence-driven approach designed to ensure analytical rigour, transparency, and consistency throughout all stages of delivery. The work program incorporates progressive stakeholder engagement, detailed analytical assessment using AusRAP, development of design guidance, validation of findings, and formalisation of outputs.

The project relies on a suite of data sources and analytical platforms relevant to road safety performance and road-design evaluation. These include AusRAP star-rating tool, Main Roads' road stereotypes and cross-section designs. Analytical modelling were undertaken using the iRAP ViDA platform to determine Star Rating Scores (SRS), star outcomes, and associated trauma-reduction potential. The assessment will consider all road-user groups, including vehicle occupants, motorcyclists, bicyclists, and pedestrians.

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The project includes the following stages.

Stage 1: Stakeholder Engagement
Engagement with Main Roads stakeholders to understand current design practices, familiarity with AusRAP methods, and constraints influencing cross-section and intersection design. This step also confirms the road stereotypes to be analysed.

Stage 2: Document Architecture Development
Preparation of draft structures for the project report and the star rating of design guideline, followed by a structured walk-through with Main Roads to confirm content and level of detail.

Stage 3: Baseline Star-Rating Assessment
Parameterisation of each Main Roads stereotype in ViDA using existing geometric, traffic, operational, and roadside attributes. Star ratings and SRS outcomes are modelled for all user groups, and sensitivity analyses identify attributes with the greatest safety influence. Where stereotypes do not meet 3- or 4-star targets, feasible upgrade pathways are developed and assessed based on safety benefit (ΔFSI), treatment cost, and required geometric or operational changes.

Stage 4: Technical Validation
A technical workshop with Main Roads validates the practicality, constructability, and policy alignment of proposed design improvements and confirms any refinements.
Stage 5: Guideline Development and Knowledge Transfer
Development of the Star Rating of Design Guideline, including a library of stereotypes, feasible upgrade options, and implementation advice. A webinar and facilitated workshop introduce practitioners to the methodology and findings.

Results
The project is currently in progress with final outputs scheduled for completion ahead of the conference. The following preliminary results summarises the AusRAP star-rating assessment outcomes for eight Main Roads' road stereotypes. Results (Table 1) are presented for all relevant road-user groups including Vulnerable Road User (VRU), followed by a concise interpretation of the primary safety risks associated with each stereotype. The following stage of the project is to refine the proposed cross-section designs to ensure minimum of 3-star standard for all road users.

Benefits to road safety
The project delivers several significant road safety benefits by transforming AusRAP star-rating evidence into practical design guidance:

1. Embeds safety performance into early design decisions: Using star ratings as a design target allows road safety risk to be evaluated and improved before construction begins, ensuring safer road outcomes from the outset.
2. Improves understanding and uptake of AusRAP across Main Roads: The project enhances awareness and capability among designers and planners, supporting more consistent application of star-rating methodology across the organisation.
3. Identifies design elements with the greatest safety impact: Through the assessment of existing stereotypes, the project demonstrates how specific features, including barriers, shoulder width, lane configuration, and intersection form, affect fatal and serious injury risk for all road-user groups, including pedestrians and cyclists.
4. Aligns new designs with network safety performance goals: Design star ratings can be directly compared with existing network ratings, allowing Main Roads to quantify the improvement achieved by a project.
5. Supports long-term trauma reduction: By focusing on attributes tied to crash severity, the project aims to achieve meaningful reductions in fatal and serious injuries across Western Australia.

Implications for policy and/or practice
The outcomes of this project have significant implications for both policy and practice, as they provide Main Roads WA with a structured, evidence-based method for incorporating AusRAP star rating targets into road planning and design. By identifying design elements that most strongly influence star ratings and developing feasible 3 and 4star design options, the project enables safer infrastructure decisions to be made at the earliest stages, before construction costs are committed. This creates a practical pathway for embedding star rating performance into design policies, cross-section standards, and intersection guidelines.

Conclusions
The project will determine, upon completion of all stages, the extent to which AusRAP Star Ratings can be effectively applied to assess and guide the safety performance of road designs across the Western Australian network. The finalised Star Rating of Design Guideline will provide a consistent and repeatable methodology for integrating AusRAP ratings into planning and design, enabling more informed and safety-focused decision-making throughout project development.

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The project will also confirm which design elements exert the greatest influence on fatal and serious-injury risk, including roadside hazards, separation treatments, lane configuration, speed environment, and the provision of facilities for vulnerable road users.

Table 1. Review of existing Main Road's stereotype

Stereotype	Star rating				Overall safety performance summary
	Vehicle	Motorcyclist	Pedestrian	Bicyclist	
Stereotype 3: Rural undivided, high-volume, 80–110 km/h, wide centreline, paved shoulders, roadside barriers	3.9	3	N/A	N/A	Meets 3-star for vehicles; moderate motorcyclist risk dominated by run-off and alignment exposure
Stereotype 4: Rural undivided, medium–high volume, 70–110 km/h, painted centreline, moderate shoulders	3.9	3	N/A	N/A	Performs similarly to S3; borderline 4-star but constrained by roadside and head-on environment
Stereotype 5: Rural undivided, medium volume, 50–110 km/h, forgiving roadside (≥6 m clear zone)	4.3	3.8	N/A	N/A	Strong rural safety performance; exceeds 4-star for vehicles and approaches 4-star for motorcyclists
Stereotype 6: Rural undivided, low volume, 80–110 km/h, narrow carriageway, very forgiving roadside	4.3	3.8	N/A	N/A	Strong performer; vehicle risk low due to forgiving roadside; motorcyclist exposure similar to S5
Stereotype 9: Urban freeway, fully divided, full access control, 70–110 km/h, barrier median	4.7	1	4.1	4	Excellent for vehicles and VRUs; extremely poor motorcyclist outcome due to high-speed, barrier-constrained environment
Stereotype 2: Rural divided, high speed (110 km/h), barrier median, wide paved shoulders	4.6	2.2	N/A	N/A	Very strong vehicle safety; motorcyclist performance constrained by high speeds and run-off consequences
Stereotype 10: Urban divided arterial, 50–90 km/h, limited median separation, roadside trees, no shoulders	3.6	3	2	1	Vehicle/motorcyclist performance moderate; VRU safety very poor, especially pedestrians and bicyclists
Stereotype 11: Urban undivided, 50–100 km/h, roadside poles/signs, narrow shoulders, residential land use	3.9	3.8	2.4	3.8	Good performance for vehicles, motorcyclists and bicyclists. Poor performance for pedestrians driven by crossing inspected road.

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AI detects unsafe behaviour at busy level crossing

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Abstract
Unsafe road user behaviour at rail level crossings poses a significant risk of catastrophic outcomes, despite relatively low crash rates. This study used artificial intelligence (AI) to analyse 170 hours of video footage from a rail level crossing to better understand violations (roads users entering an active level crossing) and to inform a coordinated Transport for NSW and NSW Police safety campaign. Although 39 near-hit pedestrian events and five near-hit cyclist events were reported by train drivers in the decade leading up to the analysis, it was unclear whether any events would be detected when analysing the footage. Using footage taken from a fixed camera at the crossing, 3173 pedestrian violations, 194 bicycle and 3440 motorist violations were found. The morning peak-period was over-represented in such events, allowing for a more informed and focused education campaign, making better use of limited police resources and maximising potential road safety benefits.

Background
ROSIICAM (Road Safety Incident Investigation Camera) is a Transport for NSW program initially implemented as a trial in 2022 at two inaugural locations. With this program, temporary cameras are set up at nominated locations and AI is used to identify incidences of 'near-hit' collisions and/or other specified unsafe travel behaviours, like vehicles waiting in the median. Details about the event, including date, time and road user information are presented on a dashboard, along with an associated video snippet. Since the initial trial, cameras have been installed at 29 sites across NSW, including busy urban locations, roundabouts and highways, with the cooperation of multiple vendors.

This paper reports on findings from the Hamilton level crossing, which was the first level crossing to be included in the ROSIICAM program. Furthermore, this location was unique in that footage was used from an existing fixed camera permanently located on site, rather than using a temporary camera, which would have been challenging to deploy within the rail corridor.

Although infrequent compared to light vehicle crashes, crashes involving trains have the potential to be catastrophic. Between July 2015 and June 2025, there were 66 collisions between trains and road vehicles at level crossings in NSW, resulting in nine fatalities and nine people seriously injured. During this same time-period in NSW, there were two collisions between trains and pedestrians, resulting in one fatality and one person seriously injured (Office of the National Rail Safety Regulator, 2026).

The Hamilton level crossing is one of the busiest in the state, with over 120 trains each day. It is controlled by flashing lights, bells and boom gates. Between July 2015 and June 2025, this crossing had no crashes but 39 near-hits involving pedestrians and five near-hits involving bicycles that were reported by train drivers to railway operators.

Consistent with the various pillars of the Safe Systems approach, Transport for NSW is improving safety at rail level crossings through multiple means, including the lowering of speeds of roads at level crossings (speeds) the removal of level crossings (roads), additional safety barriers (roads), technology trials (technology), educational campaigns (people) and enforcement campaigns (people) (Transport for NSW, 2021).

Conference theme
This paper highlights a tangible example of the conference theme 'from evidence to action', in that the study used quantitative data to inform a coordinated Transport for NSW and NSW Police safety campaign at the busy Hamilton level crossing which experienced many pedestrian and vehicle violations. Data was also shared with the Rail Infrastructure Manager to inform internal policies and risk assessments at the location moving forward. If resourcing allows, this exercise will be repeated to monitor the effectiveness of the campaign in terms of behaviour change.

Project description
170 hours of video footage was taken from one of the four existing static cameras at the Hamilton level crossing. The camera view included the crossing itself (where rail and road meet) as well as pedestrian crossings adjacent to the road.

Footage was taken from the four-week period between 8th June 2025 and 6th July 2025. This time-period was chosen to exemplify typical busy weeks (e.g. not school holidays; no planned rail closures) that also included multiple National

Rugby League (NRL) matches, as anecdotal evidence suggested that pedestrian violations may occur in the evenings when pub clientele leave nearby venues. Because resources limited the collection period to under 200 hours, the sample period was further refined to include only Wednesdays to Sundays during peak periods and evenings, when there were more train movements and it was hypothesised that there would be more pedestrian / vehicular violations. The sample footage selected for analysis was therefore skewed in an attempt to maximise hours when risky behaviour was most likely to occur at the crossing. Nevertheless, there was a concern that no violations would be found at all, given that there were only 39 near-hits of pedestrians and five near-hits of cyclists reported by train drivers in the previous ten-year period.

The video footage was then analysed using AI to identify violations. Findings were then used to inform the joint Transport for NSW and NSW Police education campaign – advising which hours and road users should be targeted and the accompanying risk-mitigating messaging.

Findings

In the 170 hours of footage, there were nearly 125,000 road users counted. There was an estimated average annual daily traffic count (AADT) of 22,715 vehicles per day and an estimate of 2,500-4,700 pedestrian movements a day.

Temporal-spatial violations were counted if road users were in the 'proximity zone' (box 1) or 'track zone' (box 2) (see Figure 1) whilst the boom gates were activated either closing before the train's arrival or reopening before the train's departure (see Figure 2). Violations in box 2 are more dangerous than those in box 1. By aligning each detected event to a defined box and timing sequence, violation severity and patterns can be identified, such as late decision-making and impatience, high-risk incursions into the rail corridor and premature departures or lingering presence after clearance.

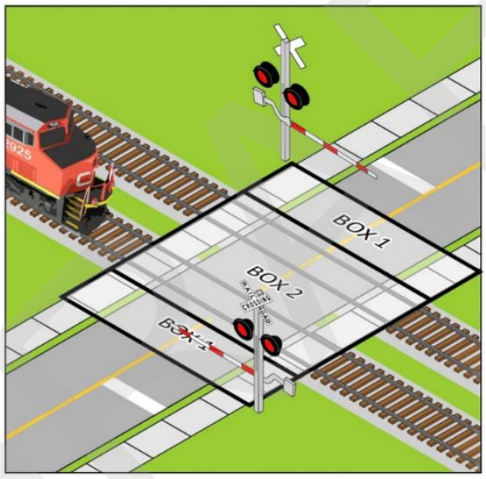


Figure 1. Spatial violation zones

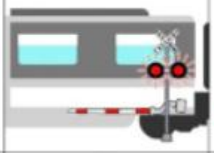
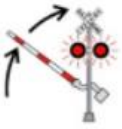
	Before Arrival			Train Passing	After Departure		
							
	B1	B2	B3	B5	A1	A2	A3
Road User in Box 1	B1-1	B2-1	B3-1	B5-1	A1-1	A2-1	A3-1
Road User in Box 2	B1-2	B2-2	B3-2	Crash/B5-2	A1-2	A2-2	A3-2

Figure 2. Violation Matrix based on Crossing Warning System Status

Most of the violations captured were either A2-2 events, B1-2 events or, to a lesser degree, B2-2 events.

- There were 5,467 A2-2 events. This was the most frequently captured violation, which occurred after the train had passed and the warning system was still deactivating. This type of behaviour indicates user-impatience, and generally poses less immediate risk, as the train has already departed. However, there are still risks, as there is the possibility of a train approaching from opposite direction or incomplete system clearance.
- B1-2 events (Pre-Arrival / Track Zone) were also frequent, with 1,219 violations captured. In this violation type, users enter Box 2 after the warning activation but before the train arrival. As this includes presence within the railway tracks during an active warning phase, this is considered as a severe violation event.

- There were 95 B2-2 events recorded (Booms Descending / Track Zone). Although these events were relatively infrequent compared with other violation types, they represent some of the highest-risk behaviours observed, given the combination of track occupancy and active warning system engagement. Figure 3 shows a still from the camera footage of an actual B4-2 spatial violation, where a B4 violation represents an interaction where the train has been detected stopped for a certain amount of time before the barriers descend again.
- There were 20 B3-2 events recorded and even fewer B1-1 and B2-1 events

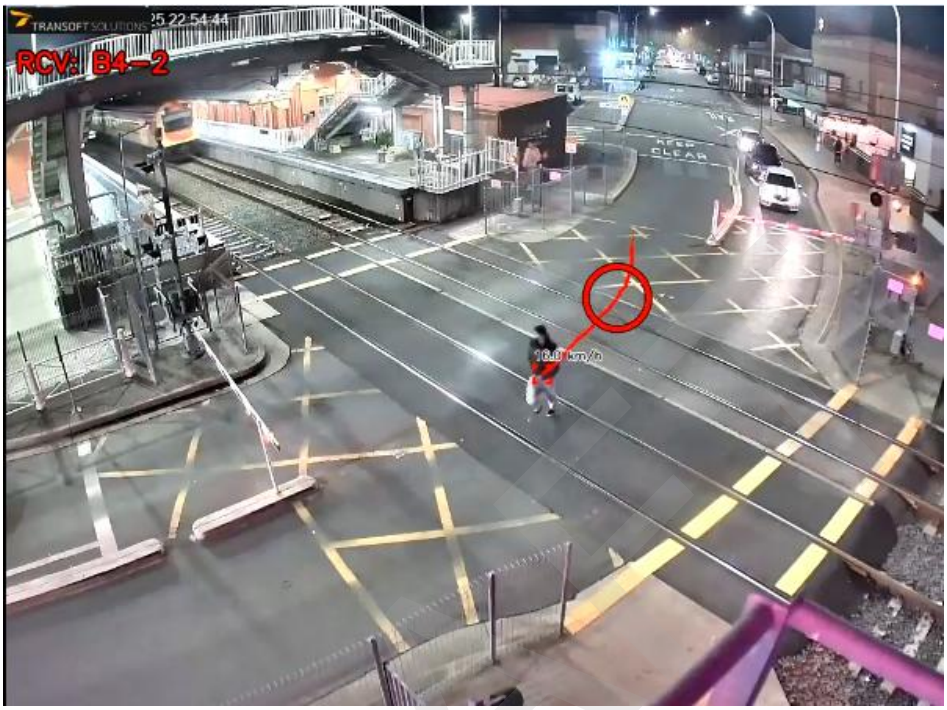


Figure 3. B4-2 Temporal/Spatial violation

Closer examination of the video snippets showed that vehicle violations primarily involved movements beyond the hold line during activation or premature departures. Pedestrian violations involved under-boom crossings, gate go-arounds or entering the track zone while warnings were still active. Several videos showed pedestrians opening the side gates in a very deliberate manner after activation, implying that these actions were systematic and not one-off occurrences. These pedestrian behaviours present the highest potential for conflict with rail movements and are considered strong predictors of future near-hit or crash risk.

Most violations were associated with light vehicles, particularly during activation phases, during the morning peak between 8.00am-9.00am. Pedestrian violations peaked at 11.00am-12pm.

Benefits to road safety

This project informed the education campaign to reduce pedestrian and vehicular near-hits / crashes with trains. This was a relatively low-cost project which has the potential to save lives at level crossings.

Implications for policy and/or practice

Quantifying unsafe pedestrian and vehicle movements at the crossing allowed for targeted education campaigns that best manages limited resources and allow for appropriately crafted safety messages.

Conclusions

Less than 200 hours of video footage analysed by AI at a busy level crossing showed thousands of motorist, bicycle and pedestrian violations, significantly more than reported near-hit events by train drivers. The violations identified by AI are a breach of the road rules and present an increased risk of collision; however, they may be less serious than those recorded by train drivers. This information was used to inform a safety campaign between Transport for NSW and NSW Police. If resources allow, a similar video analysis should be repeated to monitor the effectiveness of the campaign through behaviour change.

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Challenges of including a level crossing alert in Speed Adviser

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Abstract
The NSW government launched Speed Adviser, a free smartphone application that reminds drivers of the posted speed limit, in 2014. Speed Adviser provides drivers with spoken and visual warnings when the speed limit is exceeded or when drivers enter a school zone. The application has been downloaded over 140,000 times since its launch. In 2024, a new feature was added alerting drivers when they approach one of over 1,100 level crossings on NSW public roads. The update uses visual and audio alerts to notify drivers as they approach these level crossings. This is a low-cost, equitable solution that reminds drivers to be vigilant as they approach a level crossing. This feature benefits those living in or visiting regional areas, where most level crossings are located. This paper explores the technical challenges of introducing this new feature.

Background
Between July 2015 and June 2025, there were 66 collisions between trains and road vehicles at level crossings in NSW, resulting in nine fatalities and nine people seriously injured. Whilst these incidents are relatively rare, collisions involving trains and vehicles can be catastrophic. Of the 1,309 public road level crossings in NSW, 454 have active traffic controls (148 have flashing lights and bells, 304 have flashing lights, bells and boom gates and 2 have manually operated booms/gates). Most other crossings are passively controlled by ‘give-way’ or ‘stop’ signs.

Transport for NSW is improving safety at rail level crossings in various ways. In addition to removing rail level crossings where possible and employing educational campaigns, the government is also trialling various technology to warn drivers that they are approaching a crossing. The NSW Centre for Road Safety introduced a new feature in its free smartphone application Speed Adviser in 2024 that warns drivers when they are approaching a level crossing on a public road. There were many technical challenges with introducing this low-cost solution.

Speed Adviser application
Speed Adviser uses the Global Navigation Satellite System (GNSS) receiver on a user’s phone to monitor a driver's location and speed. It alerts drivers with visual and audible warnings if they exceed the speed limit. Speed Adviser shows the current road speed limit. It uses the latest speed zone data available for NSW roads, including all school zones and their operating hours. Speed Adviser also knows where mobile speed cameras may be in operation and warns drivers when they enter a mobile speed camera zone. Since its addition in 2024, Speed Adviser also alerts drivers when they approach a rail level crossing on most public roads.

Speed Adviser is available for free for all NSW road users with a full licence. Speed Adviser covers over 225,000 kms of roads, effectively covering the entire state. Most level crossing within NSW are in regional areas. Fatal crashes are disproportionately higher in regional areas, so this new level crossing alert will particularly benefit regional drivers.

Whilst Speed Adviser is effectively a driver’s aid to help them drive within the speed limit, the app also helps to protect some of our most vulnerable road users – school children. Speed Adviser warns drivers as they are entering school zones. Speed Adviser knows when school is in term and when school zones are active, including non-standard school zones. Assisting drivers to stay within the speed limit helps protect *all* road users, not just drivers.

Conference theme
This work represents a practical application of ‘Evidence to Action’. Collisions between trains and vehicles at level crossings are a major road safety risk. The Speed Adviser smartphone application is an example of how technology was created to assist drivers and then evolved to include new alerts, like this ‘level crossing alert’.

Project description
The project aim was to include a low-cost solution to alert drivers approaching level crossings on public roads. This alert was to be included in the existing Speed Adviser application. Human factors design principles were considered with this development, as there is a delicate balance between offering useful information to drivers without over-stimulating or distracting them. The audio-visual alerts do not require drivers to look directly at their phone or interact

with it in any way. If they were to look at their phone, the new level crossing alert (Figures 1 and 2) is similar to familiar road signs. The meaning of the pictogram is intuitive, so that no new learning is required for app users.

Figure 1. New level crossing alert within the Speed Adviser smartphone application

Figure 2. New level crossing alert that resembles existing road signs

Findings

There were many challenges of including the new level crossing alert, as the application does not have navigational functionality. Therefore, it is not possible to know where drivers are heading. Given these limitations, the team created a zone along the road on either side of the level crossing, similar to how a 'school zone' is treated in the application. Upon entering the zone, drivers are given an audio-visual alert. Ideally, the visual alert would disappear as drivers crossed through the level crossing. However, the challenge lay in the fact that there is no lane-level directional data in the road segments, so a single zone had to be created that covered both sides of the crossing. The result is that drivers receive an audio alert just once as they enter the level crossing zone and the visual alert disappears after they exit the zone on the other side of the crossing.

The length of each level crossing zone varies depending on the road speed. Guidelines are based on the speed at which 85 percent of vehicles travel under free-flowing conditions on the road perpendicular to the crossing. On higher speed roads, drivers are alerted from further away from the crossing, to give them more time to react. The distances align with Australian Standards for signage (Australian Standards, 2016) (See Table 1).

Table 1. Distances of advanced level crossing warning sign placement by 85th percentile speed

V_{85} Km /h	Metres away from level crossing at which sign / alert is placed
<75	120
75-90	180
>90	250

If there is no intersection road prior to the crossing, then the audible alert 'caution: rail crossing ahead' is accurate. In many instances, the geometry of the road means that drivers are given very little warning if they turn onto a road just before an approach to a level crossing (see Figure 3). In Figure 3, drivers who are travelling parallel to the rail line from the south would have very little warning if they were to turn on to the road with the level crossing. This, however, would likely mimic actual warning signs. There are an estimated 67 crossings like this on public roads in NSW, where drivers would have less than 30 metres of road before the level crossing. The challenge is how to handle cases where a driver can turn onto the road and drive away from the crossing. These drivers are still entering the 'level crossing zone,' yet would erroneously receive an alert. In these instances, the team had to manually intervene and make a risk/benefit decision as to the likelihood a driver using the application would be turning towards the crossing or not and whether it would be better for them to receive an erroneous alert or receive an alert at very short notice.

Another challenge encountered when creating 'level crossing zones' was when road names changed on either side of the crossing (Figure 4). In these instances, the zone would only be created on one side of the crossing. To rectify this, the team deemed that if the angle of difference between the two roads was less than 30 degrees, then the road should be considered an extension of the same road.

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Figure 3. Challenging example of a level crossing with short stacking

Figure 4. Example of road name changing on either side of level crossing

Benefits to road safety

Level crossings, where rail and road meet on our network, present a heightened risk of collisions. Though NSW is actively working to remove level crossings where possible, this is extremely costly and impractical at most locations. In addition to education campaigns and providing additional physical barriers at level crossings, NSW is also employing other technologies to minimise crashes at level crossings. Speed Adviser is a free smartphone application that is available to all full-licence holders in NSW. This new alert provides an audio-visual reminder to drivers that they are approaching a level crossing on a public road and need to exercise caution.

Implications for policy and/or practice

Technology is only one of the pillars of the Safe Systems approach. Whilst this smartphone application will not eliminate the risk of a crash at a level crossing on a public road, it is an equitable low-cost solution currently available until more sophisticated technologies are considered, like advising drivers when a train is actually on approach.

Conclusions

It was challenging to implement this new alert into Speed Adviser, particularly because there is currently no navigational functionality. To date (over two years since the release of this feature), no complaints have been received from users about their interactions with this new feature, though there have been media releases and social media posts that have been posted and re-posted at the launch of the new alert.

This new rail level crossing feature will continue to exist in its current form within the Speed Adviser application. However, technology continuously evolves. Should Speed Adviser be redeveloped to include navigational functionality, then users could be given alerts about upcoming level crossings at a timed interval before their approach based on their speed, regardless of whether they're turning onto a road with short stacking. Such enhanced functionality would give drivers ample warning of the upcoming potential hazard (a rail level crossing) and give them more time to react, further enhancing the road safety benefits of this new feature. Train timetable information could also be integrated, so that alerts are given when a train is scheduled to approach. At this moment, there is not a low-cost solution to do this for all level crossings on public roads, particularly at passive crossings, where this would be most beneficial.

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I was asleep: semi-structured interview insights with food delivery riders

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Abstract
Food delivery riders (FDR) play a critical role in urban logistics but face substantial road safety risks driven by economic pressure, infrastructure gaps and unstable vehicles. This study explored these risks through semi-structured intercept interviews with riders in Melbourne. Thirteen riders participated, discussing motivations, operational challenges, risk perceptions and views on e-bike and trike-style vehicle designs. Thematic analysis identified financial drivers of unsafe behaviour, cognitive overload, hazardous weather interactions, vehicle instability and tensions between efficiency and safety. Riders expressed interest in safer vehicle configurations, particularly three-wheel 'tadpole' trike concepts, though concerns emerged around manoeuvrability, regulatory compliance and maintenance. Findings highlight the need for safe system approach vehicle design and practical recommendations towards improved stability and ergonomics, clear standards for FDR vehicles and incentives for adoption. This work translates lived experience into actionable interventions with potential to reduce crash and injury through safer vehicle design.

Introduction
Food delivery riders (FDR) increasingly support last-mile urban logistics. Despite their visibility, FDR experienced high rates of crashes, near-misses and injuries while working due to long hours, unpredictable traffic, rider fatigue, adverse weather and vehicle limitations (Bertenshaw et al., 2022; McKinlay et al., 2022). Besides platform economics and job quality pressures documented in the literature (Goods et al., 2019; Veen et al., 2020), the specific contribution of vehicle design to safety outcomes remains under-examined. This study addresses that gap by investigating riders' lived experiences through semi-structured interviews and analysing how vehicle stability, ergonomics and load management may mitigate collisions. Findings provide an evidence base for Safe System Approach interventions aimed at reducing trauma among gig-economy road users (Mooren et al., 2011).

Conference theme
This research advances the ARSC2026 theme From Evidence to Action: Shaping a Brighter Future by converting riders' real-world experiences into actionable design and policy directions. Evidence from interviews was analysed into practical vehicle design recommendations (e.g., improved stability and ergonomics) and system-level actions (e.g., standards for gig vehicles and adoption incentives), consistent with Safe System thinking (Mooren et al., 2011) and recent insights on delivery cyclist experiences in Australian cities (Thorpe et al., 2024).

Method
A qualitative method captured the complexity of FDR experiences as semi-structured intercept interviews (Monash University ethics approval no. 43662). These were conducted in two high-activity delivery hubs in Melbourne (Box Hill and the CBD). Thirteen riders were recruited during off-peak periods to minimize disruption. Interviews were conducted in English or Mandarin, audio-recorded with consent to participate and transcribed verbatim. The method explored motivations for gig work, operational patterns, risk perceptions, crash experiences, weather-related challenges and views on vehicle stability and design. A six-phase thematic analysis approach was used to code and interpret the data, identifying patterns related to safety behaviours, environmental influences and vehicle expectations (Braun & Clarke, 2006).

Results
Food delivery riders described a complex working environment shaped by multiple operational and contextual pressures. Many reported long working hours and strict income goals, noting that bonuses, incentives, and algorithmic performance scoring often pushed them toward risky behaviours, including riding in hazardous weather, skipping rest breaks, and speeding (Goods et al., 2019; Veen et al., 2020). Riders also highlighted a range of situational hazards, such as rain, slippery surfaces, and tram tracks, which compounded the risks of their work. These conditions were further worsened by cognitive overload from multi-apping, with some riders describing incidents of lack of sleep while riding. In addition to behavioural and environmental challenges, many riders expressed concerns about vehicle design. They noted that e-bike instability often caused by weight distribution and high centres of gravity contributed to a tipping risk, especially when carrying heavy loads. Opinions on features such as backrests varied due to the need for frequent mounting and dismounting. When presented with safer vehicle concepts, such as a three-wheel "tadpole" trike, riders acknowledged potential gains in stability but also raised concerns about increased width, reduced manoeuvrability, higher maintenance costs, and possible regulatory barriers.

Benefits to road safety
This research focuses on reducing crash likelihood for FDR. Vehicle stability, ergonomic comfort and appropriate load distribution are design factors to reduce falls and rollovers. Meanwhile behaviour-aware interventions support safer operations.

Implications for policy and/or practice
This study highlights the importance of integrating FDR needs into transport safety, emphasising vehicle design, regulation, infrastructure, and app "platform" accountability. A key priority is the establishment of minimum safety standards for gig-worker e-bikes and trikes including stability, braking performance, and load-distribution requirements supported by clear compliance

requirements. It is essential to strengthen enforcement around speed-assistance limits and modification controls, while still allowing legitimate safety-focused retrofits. Policy mechanisms such as subsidies and leasing schemes could incentivise the adoption of safer vehicle types aligned with Safe System principles (Mooren et al., 2011). In addition, infrastructure planning should better reflect delivery riders' real movement patterns by addressing "social space", particularly around tram-track interfaces and high-demand kerbside areas (Napper et al., 2026). Finally, applying Safe System vehicle principles within gig-economy policy frameworks and platform governance models would strengthen accountability and support safety at a systemic level (Salmon et al., 2023).

Conclusions

Food delivery riders operate in environments where economic pressure, unstable vehicles and urban conditions elevate crash risk. Rider-centred qualitative evidence in this study underscores the value of Safe System-aligned vehicle design and supportive policy. Future work should include pilot trials of safer vehicle concepts and explore regulatory pathways to integrate gig-mobility vehicles into Australian transport systems.

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DRAFT

Unlocking local government's delivery potential: from evidence to action

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Abstract
More than half of fatal and serious injury crashes in Australasia occur on local roads. To achieve broader road safety targets, local government represents a significantly underutilised opportunity to translate evidence into action. Clear, agreed advocacy priorities through engagement are a proven way to drive change. This interactive workshop will identify which advocacy priorities best engage, empower, and equip local government to leverage its close community connections and accelerate road safety delivery. Led by the ACRS Local Government Network, the workshop brings together experts and practitioners from across the road safety system to critically test and strengthen draft advocacy priorities. Through facilitated discussion and participant voting, attendees will contribute to and help shape refined, evidence informed ACRS Local Government Road Safety Advocacy Priorities for consideration by the ACRS Council. The workshop provides a platform for collective action, ensuring local government advocacy is targeted, credible, and ready to drive implementation.

Introduction
Road safety targets cannot be achieved without significant safety improvements on local roads. However, over recent decades, improvements on local roads have not kept pace with those on national and state road networks (Job et al., 2025). In Australia, less than 40% of travel occurs on local roads, yet more than half of all fatal and serious injury crashes occur on these roads (McTiernan, 2019).

Local government's role in road safety delivery is well recognised (Shelton et al., 2021). Collectively, local government manages 82% of the Australian and 88% of the New Zealand road networks by length (Durdin & Tuke, 2020). As such, local government is a critical delivery partner in effective road safety management, and supporting local government capability is a proven road safety intervention (Job et al., 2025).

The purpose of the Australasian College of Road Safety (ACRS) Local Government Network (LGN) is to be a leading voice for local government road safety—connecting professionals and practitioners, sharing knowledge and experience, and advocating for change through a united platform covering Australasia and beyond. The LGN invites people from all disciplines and levels of experience to share their thoughts in this highly interactive workshop.

Over the past year, the ACRS LGN has led extensive engagement across the local government sector to prepare a current state assessment of road safety practice by jurisdiction and to develop an optimal model for local government involvement in road safety action. This workshop builds on a LGN workshop held at ARSC Perth 2025 and a LGN webinar delivered in March 2026 on *Road Safety Management in Local Government*. This work identified key areas where targeted support could unlock local government delivery potential, including governance arrangements, dedicated road safety funding, program level funding support, capacity and capability building, access to tools and guidance, and investment in dedicated road safety roles.

Building on this foundation, the workshop deliberately shifts from diagnosis to action by testing which advocacy levers are most likely to unlock local government delivery potential at scale. Evidence shows that clear and agreed advocacy priorities, developed through broad engagement, are an effective way to achieve advocacy goals (Lazuka-Nicoulaud et al., 2022). However, local government road safety advocacy has often been constrained by misalignment between policy ambition, process maturity, and political support, with responsibility frequently falling to road safety practitioners with limited support from higher levels of government (Turner et al., 2025). Agreed advocacy priorities provide an opportunity to remove these barriers by targeting the most effective actions that will strengthen local government's contribution to road safety outcomes and help shape a brighter future.

Conference theme
This interactive workshop directly addresses the conference theme *From Evidence to Action: Shaping a Brighter Future* by recognising local government as a significant and currently underutilised opportunity to translate evidence into

action where road users are most vulnerable. Experience shows that many road safety programmes stall during implementation due to community resistance or insufficient engagement to build support for change. Local government's close connections with communities provide a natural advantage in the engagement process compared with state or national governments (Job et al., 2025). Without a local government sector that is fully engaged, empowered, and equipped to deliver road safety action, progress from evidence to action will remain incomplete and Vision Zero delayed.

Facilitator

Ping Sim is a Principal Advisor Transport Safety at Auckland Transport and an experienced facilitator in a local government and road safety context. She led stakeholder and community workshops to develop Auckland's Speed Management Plan, involving indigenous partners, elected members, health representatives, and emergency services. Ping contributed to the Auckland Safe Speeds programme, which received a Prince Michael International Road Safety Award in 2024. She has delivered Vision Zero learning experiences for the Auckland Transport Board, executive team, and senior management, and has presented Auckland's local government case study on speed management to the World Bank and through a Global Road Safety Executive Leadership Course. Ping led the development of Auckland's Vision Zero strategy, which was awarded a Trafinz Road Safety Leadership Award in 2020. She is a committee member of the ACRS Local Government Network and NZ Chapter.

Workshop leaders

Brett Williams has over 20 years' experience in traffic engineering and transport planning and works at the City of Onkaparinga, South Australia. A member of the LGN since its inception and now Deputy Chair, Brett has helped prepare and facilitate LGN workshops at every Australasian Road Safety Conference since 2023. He has represented local government on multiple Austroads project working groups and was co-convenor of the 2025 National Transport Conference.

David McTiernan is a highly experienced road safety engineer with more than 30 years' experience across local government and applied research roles, including 18 years with the National Transport Research Organisation (formerly ARRB). As Director and Principal Engineer at Zero Transport Safety Advisory, he advocates for stronger national and jurisdictional support to enable local government road safety action and contributes actively to ACRS Council, IPWEA, and the LGN.

Format	Activity	Lead	Description
Presentation	Background Context	Facilitator	Introduction and purpose of workshop. Context and recap of work to date.
Panel	Panel	Facilitator	Expert panel members speak for 3 minutes each on best practice to enable local government road safety action. Panellists confirmed to date: Melanie Suitor (LGN creator and Chair, over 20 years of experience working in local government road safety, awarded the Senator Alex Gallacher Award for her commitment to local government road safety). In principle support from the following organisations to speak to these topics, name of representative to be confirmed: **Transport Accident Commission**: Supporting local government in Victoria through the Safer Roads Programme. **WALGA**: proactively engage, motivate and support local governments in Western Australia through the RoadWise Councils initiative. **Australian Local Government Association**: Advocating for local government financial sustainability and effective public policy in Australia.
Interactive	World Cafe	Workshop leaders/ LGN committee	In groups, participants discuss blockers, enablers and a draft advocacy priority. Groups rotate, each person visiting three tables.
Discussion	Shareback 1	Workshop leaders/LGN committee	Table facilitators share key results, including any additional or modified advocacy priorities to be included in voting activity.
Interactive	Voting on priorities	Workshop leaders/LGN committee	Participants receive coloured sticky dots which they use to vote for which priorities they see as most important
Discussion	Shareback 2	Workshop leaders/LGN committee	Table facilitators share voting results

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Presentation	Conclusion	Facilitator	Facilitators share next steps, close session

Interactive Workshop outcomes and actions

The purpose of the interactive workshop is to engage diverse expertise from across the road safety system to refine identified areas of opportunity into a set of draft Local Government Road Safety Advocacy Priorities and associated advocacy actions.

Planned outcomes and actions include:

- Collection and synthesis of participant feedback and insights by the ACRS LGN.
- Development of a draft set of Local Government Road Safety Advocacy Priorities, supported by evidence and rationale.
- Submission of draft priorities to the ACRS Council for review and feedback.
- Refinement and endorsement by the ACRS Council to establish an agreed, publicly accessible set of advocacy priorities.
- Use of the endorsed priorities to inform the development of an advocacy plan identifying key stakeholders, audiences, and actions.

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Addressing inequities in regional and Aboriginal post-crash mental health

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Presenter: Ian Holbrook

Abstract

Road traffic incidents have profound psychological and social impacts, particularly for individuals and communities in regional and remote Australia. Despite experiencing a higher burden of road trauma, these communities remain significantly underrepresented in post-crash mental health support services, particularly among Aboriginal and Torres Strait Islander peoples. Service utilisation data from Injury Matters' Road Trauma Support WA service confirmed low regional and Aboriginal engagement, highlighting a clear access gap. In response, two new roles, Regional Liaison Coordinator and Aboriginal Engagement Coordinator, were established to strengthen cultural safety, improve referral pathways and increase awareness of post-crash care. Early findings indicate growing service utilisation alongside strengthened partnerships with Aboriginal Community Controlled Health Organisations and improved culturally appropriate resources. The implementation of dedicated regional and Aboriginal engagement activities is vital to improving recovery outcomes, reducing long-term psychological harm and achieving a more equitable post-crash system.

Introduction

In 2025, 1,316 people died on Australian roads, with many more injured and/or traumatised as a result of the hundreds of thousands of crashes that occur nationwide each year (Department of Infrastructure, Transport, Cities and Regional Development, 2026). Alarmingly, approximately 60% of these road fatalities occurred on regional or remote roads in Australia. The impact of a road traffic incident on individuals and the broader community is profound. Road trauma can ripple through people's lives in many ways, often leaving those involved feeling stressed, overwhelmed, helpless and vulnerable.

The World Health Organization recognises mental health care and psychological support as essential components of the post-crash response due to its role in mitigating grief, anxiety and other trauma reactions (World Health Organization, 2016). Without appropriate support, psychological distress can become a mental health condition that interferes with reintegration into work, family and social life. Despite this, the mental health consequences of road trauma are often overlooked in comparison to physical rehabilitation, particularly in regional and remote areas where access to emergency care, rehabilitation and post-crash mental health support is limited (Trajchevska & Jones, 2025).

It is well documented that Aboriginal and Torres Strait Islander peoples experience a disproportionate burden of road trauma. Concerningly, Aboriginal and Torres Strait Islander people are 1.6 times more likely to be hospitalised due to a road crash and 3.8 times more likely to die in a road crash than non-Aboriginal and Torres Strait Islander people (Australian Institute of Health and Welfare, 2025). Furthermore, approximately 60% of Aboriginal and/or Torres Strait Islander peoples reside in regional or remote areas of Australia, amplifying existing barriers to timely post-crash support (Australian Bureau of Statistics, 2023).

Aboriginal and Torres Strait Islander health is further shaped by broader health and social determinants, often resulting in communities experiencing reduced access to primary health care, higher injury hospitalisation rates, disrupted continuity of care and the ongoing impacts of intergenerational trauma and institutional racism (Nolan-Isles et al., 2021). These experiences can affect trust in mainstream health services and contribute to lower engagement with post-crash support services. Meaningful engagement and effective post-crash support must therefore be grounded in Aboriginal and Torres Strait Islander concepts of health, which encompass holistic wellbeing, connection to land, kinship, identity and community (Dudgeon et al., 2014). When services do not reflect these cultural foundations, they risk contributing to mistrust, disengagement and poorer recovery outcomes.

Together, these factors highlight the need for culturally grounded, community-driven and trauma-informed approaches to post-crash care across Australia. Injury Matters' delivery of Road Trauma Support WA (RTSWA) is situated within this context. Addressing these inequities requires support pathways that honour cultural identity, strengthen trust, improve regional accessibility and ensure Aboriginal communities are active partners, not passive recipients, in post-crash recovery.

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Conference theme

Injury Matters is translating evidence into action to address inequities in post-crash support across Western Australia. Service utilisation data, community knowledge and lived experience consistently highlight that people living in regional and remote areas, as well as Aboriginal and Torres Strait Islander peoples, face substantial barriers when accessing psychological support after a crash. Guided by these insights, RTSWA has implemented targeted, evidence-based strategies to strengthen accessibility, cultural safety and service responsiveness.

Project description

Injury Matters delivers RTSWA to reduce the ongoing psychological, emotional and social impacts experienced by people affected by road trauma. RTSWA provides free, trauma-informed information and support, education and training, and personalised, person-centred counselling, regardless of when the incident occurred or the individual's level of involvement. All services are developed with and for the community to ensure they reflect real needs, support each person's unique recovery journey and promote long-term wellbeing.

Between July 2022 and June 2025, RTSWA delivered 2,405 in-person, telephone and online counselling sessions to 655 clients. Service utilisation increased substantially over this period, from 587 sessions in 2022-23 to 1,069 sessions in 2024-25, indicating growing community awareness and need. Despite this growth, an analysis of client demographics revealed significant gaps in access. Only 24.7% (n=162) of clients reported living in regional areas of Western Australia, despite regional and remote areas experiencing a disproportionate burden of serious road crashes. Engagement with Aboriginal and Torres Strait Islander peoples was also significantly lower than expected, with only 2.7% (n=18) of clients identifying as Aboriginal and/or Torres Strait Islander. These utilisation figures provide the baseline evidence underpinning the targeted intervention and now serve as key evaluation measures for assessing future improvements in equity of access.

To address these gaps, Injury Matters has established two new roles: the Regional Liaison Coordinator and the Aboriginal Engagement Coordinator. These positions enhance RTSWA's reach, cultural safety and local relevance by strengthening connections with regional communities and Aboriginal stakeholders. Together, these roles support statewide commitments to equitable post-crash care and ensure that individuals most affected by road trauma can access timely and culturally appropriate support.

The project is being evaluated using the RTSWA Evaluation Framework, which monitors implementation and outcome indicators across service access, stakeholder engagement, and client outcomes. Baseline measures have been established to support future outcome evaluation.

Results

Early implementation findings indicate meaningful progress in strengthening the accessibility, cultural safety and community reach of RTSWA through targeted regional and Aboriginal engagement activities.

The introduction of the Regional Liaison Coordinator and Aboriginal Engagement Coordinator roles has enabled more consistent engagement with communities across Western Australia and improved the cultural relevance of service delivery. Both coordinators bring valuable cultural knowledge, community connections and lived experience, and their work has been supported by organisation-wide training in Social and Emotional Wellbeing frameworks and culturally safe practices.

A comprehensive review of RTSWA's service processes, referral pathways and therapeutic approaches was completed, resulting in exploring clearer pathways into the service and more culturally secure client experiences. This work has been complemented by the redesign of key resources, including factsheets and posters incorporating Aboriginal artwork, language and imagery, which have enhanced the visibility and cultural appropriateness of the service.

Engagement with key stakeholders has expanded significantly. Coordinators have undertaken active outreach to Aboriginal Community Controlled Health Organisations across Western Australia and strengthened collaboration with Aboriginal Liaison Officers in metropolitan and regional hospitals. The development of a Regional Engagement Strategy has provided a structured approach to prioritising activities in areas with high crash incidence and historically low service utilisation. Increased community visibility, including a live interview on Noongar Radio, has generated new training requests from metropolitan health services, signalling growing recognition and trust in Injury Matters and RTSWA.

Collectively, these early findings demonstrate progress toward more equitable access, stronger referral pathways and culturally secure service delivery. While full quantitative outcome evaluation will occur from 2026 onwards, the early implementation evidence suggests that the targeted engagement roles are beginning to address the access gaps identified in baseline service utilisation data.

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Benefits to road safety

Research demonstrates that psychological distress, trauma and mental health conditions can impair cognitive functioning, attention, reaction time and decision-making, increasing the risk of unsafe driving. Providing trauma-informed counselling and recovery support helps individuals manage distress, rebuild confidence and safely re-engage with the road environment, reducing the likelihood of ongoing psychosocial impacts that may contribute to future road safety risks.

Implications for policy and/or practice

Embedding sustainable improvements in post-crash mental health care will require coordinated policy action across the road safety and health sectors. The findings support greater investment in culturally secure, regionally responsive post-crash mental health services nationwide.

Policy makers should strengthen referral pathways between hospitals, Aboriginal Community Controlled Health Organisations and specialist support services, integrate psychosocial recovery indicators into state and national road safety strategies, invest in culturally secure workforce development, expand regionally responsive service models and embed cultural governance and Aboriginal leadership in post-crash system design. Together, these policy directions align with early project findings demonstrating that culturally grounded engagement improves access, strengthens trust and supports safer long-term recovery pathways.

Conclusions

The establishment of dedicated engagement roles and a structured evaluation framework provides a strong foundation for improving service access, cultural safety and recovery outcomes. Early findings show strengthened partnerships, improved cultural security and increased service visibility. As post-crash psychological care is increasingly recognised as a critical component of a safe road system, expanding culturally secure, regionally responsive support will be vital to improving equity and recovery outcomes for communities disproportionately affected by road trauma.

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DRAFT

Rural compact roundabouts safety performance, design and operation

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Abstract
Rural compact roundabouts utilise Raised Safety Platforms to manage approach and entry speeds safely. They offer potential cost savings with a smaller land footprint than conventional designs. Road Safety Victoria evaluated these single-lane intersections to inform updated design guidance, aiming to transition compact roundabouts from a design exception to mainstream practice. This shift supports the broader goal of increasing Safe System infrastructure across rural road networks. This evaluation compared compact and conventional design performance across several areas. Findings revealed that compact designs provided equivalent or superior speed and safety outcomes, acceptable comfort and safe turning performance for heavy vehicles. Community feedback was generally positive, particularly in relation to perceived safety and use. Although their maximum traffic capacity was 35% lower than for conventional designs, this did not present an operational issue on lower-volume roads. Ultimately, compact roundabouts offer a more cost-effective solution for improving safety at rural intersections.

Background
Approximately 6% of all fatal and serious road trauma in Victoria occurs at high-speed rural intersections (≥ 80km/h). This is due to the high impact and kinetic energy, combined with limited vehicle occupant protection in crashes occurring at >50 km/h.

Roundabouts on these roads are aligned with the Safe System approach and are highly effective as road safety treatments for vehicle occupants. They reduce fatal and serious crash risks by managing speeds, collision angles and reducing conflict points. Conventionally, their high construction costs limit widespread implementation in treating rural road trauma, inhibiting progress towards the 2050 strategic road safety goal of eliminating road deaths and serious injuries. These higher costs stem from land acquisition, service relocation, and large intersection footprints, often requiring tree removal. Thus, only several rural roundabouts could be built annually, leaving many intersections untreated when funding is limited.

Compact roundabouts (Figure 1) were developed to address these cost limitations. Compact designs aim for equivalent safety benefits as conventional roundabouts while reducing their land footprint and costs. Single-lane designs are better suited to lower-volume, rural, high-speed roads and were the subject of the evaluation led by Road Safety Victoria in the Department of Transport and Planning (DTP). Compact roundabouts had:

- a smaller central island with a mountable apron,
- a single curve entry,
- some form of approach speed management such as Raised Safety Platforms (RSPs),
- sometimes with an extended median.

Figure 1: Example of a compact roundabout (Lance Creek)
Source: Department of Transport and Planning (reproduced with permission)

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Conference theme
This evaluation provided evidence to inform updated design guidance, aiming to transition compact roundabouts from a design exception to mainstream practice. This will enable practitioners to action more Safe System infrastructure on high-speed rural roads.

Project description
Integrated transport approach required that this evaluation considered rural compact roundabout performance in context of safe speed management (no sudden reductions, entry speeds), Safe System alignment (probability of fatal or serious injury, crash reduction factor), vehicle occupant comfort (RSP vertical acceleration), safe heavy vehicle turning speeds (rollover risk), intersection capacity and delay, noise and emissions, community sentiments and perceptions, and the overall economic benefits and limitations.

Each objective was investigated by comparing compact performance with agreed threshold values (e.g., from Safe System theory, Austroads design guidance), or with performance of similar conventional roundabouts. Compact - conventional pairs and cohort statistical tests were conducted to test significance of differences in relevant metrics. Between three and seven compact sites were used to evaluate each objective, often considering individual approaches to maximise data. A range of design choices were evaluated. The evaluation translated the obtained evidence into specific recommendations for design guidance revision. For full methodology, results and findings see Jurewicz et al. (2026).

Findings
Adequacy of approach and entry speed management
Compact roundabouts effectively reduced approach and entry speeds to levels considered safe and consistently lower than at conventional roundabouts (Figure 2). RSPs and smaller central islands ensured controlled deceleration (≤ 20 km/h at any design element) and safe entry speeds, including for heavy vehicles. All roundabout entry operating speeds were well within expectations, below the maximum 50 km/h recommended by Austroads.

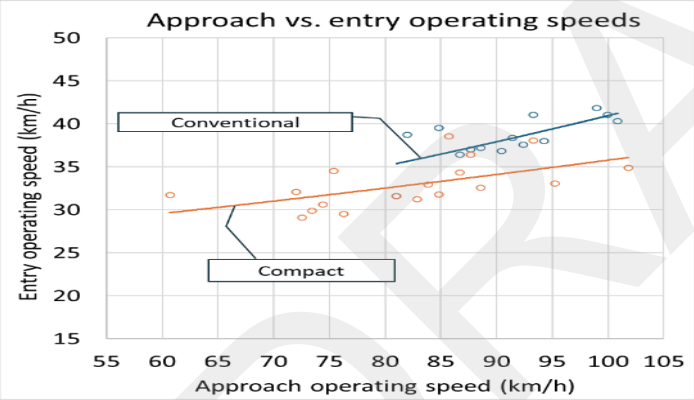

Figure 2: Approach and entry operating speed performance of compact and conventional roundabouts
Source: Department of Transport and Planning (reproduced with permission)

Safe System alignment and crash risk reduction
Thanks to low entry and circulating speeds, and shallower impact angles, compact designs showed strong Safe System alignment. Probability of Fatal or Serious Injury (FSI) outcomes in vehicle-vehicle crashes was lower, yet comparable with conventional roundabout designs. Collision likelihood (conflict) indicators for intersection, rear-end and run-off-road were also lower or similar to conventional designs, with no differences for heavy vehicles. An FSI Crash Reduction Factor of 74% was estimated, which was higher than the adopted 65% for conventional roundabouts (Department of Transport and Planning, 2024).

Effectiveness of RSPs
Testing using instrumented passenger and heavy vehicles confirmed RSPs effectively managed speeds while keeping vertical acceleration within comfort thresholds (<0.7g). Ramp construction improvements were recommended to enhance RSP effectiveness and potentially reduce overall costs.

Heavy vehicle stability and performance
Modelling confirmed that compact roundabouts provided safe turning performance[1] for heavy vehicles, including semi-trailers, B-doubles and large buses, at appropriate speeds. Mountable aprons supported these movements while allowing

[1] Maximum safe turning heavy vehicle speeds of at least 11-15 km/h were required by Austroads (2023) design guide for the relevant range of roundabout radii and crossfalls. All compact maximum safe turning speeds were in the 15-20 km/h range.

for a smaller intersection footprint. Modelling indicates that RSP ramps did not cause heavy vehicle instability when travelling through roundabouts.

Capacity limits

Compact roundabouts maintained sufficient operation under rural traffic conditions. Maximum capacity was defined by traffic demand resulting in a sharp rise in average peak-hour control delay, >15 sec/vehicle. Based on the SIDRA modelling, this maximum capacity was about 35% lower for compact roundabouts (12,000 vs. 20,000 vehicles per day), (Figure 3). This constraint was acceptable for many rural routes which experience lower traffic volumes - and therefore do not approach the capacity limits of intersections. This design may not be suitable on high volume routes where intersections are already close to capacity. Also, maximum capacity could vary significantly between individual sites.

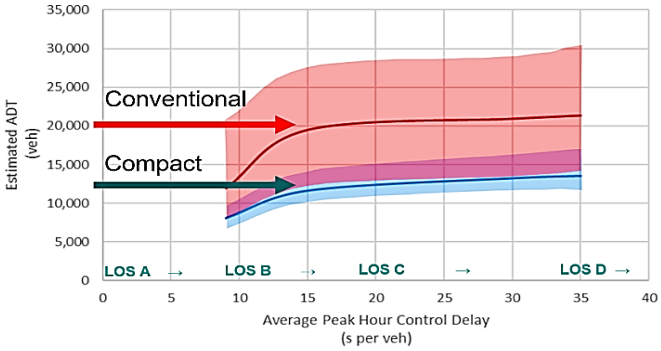

Figure 3: Peak delay vs. daily traffic demand at compact and conventional roundabouts
Source: Department of Transport and Planning (reproduced with permission).

Emissions and noise impacts

Both emissions and noise were found to be lower at compact roundabouts; however, these findings are considered inconclusive for assessing long-term environmental benefits. Specifically, the lower modelled CO_2 emissions per vehicle-kilometre could be attributed to model assumptions, such as smoother vehicle acceleration and deceleration profiles, rather than real-world emissions. Recorded vehicle noise levels were 6-7 dB(A) lower at compact roundabout ramps. This reduction was likely influenced by new pavement surfaces at the compact sites, rather than by speed or operational differences.

Community perceptions & sentiments

Compared to intersections without a roundabout, 76% of surveyed local road users felt that compact roundabouts were safe. A similar proportion were positive about ease of driving through a compact roundabout. These sentiments were supported by heavy vehicle drivers. There were individual constructive comments related to the designs being uncommon in rural areas, surprising to some cyclists and using many warning signs.

Benefits to road safety

The evaluated compact roundabouts costed 10% less than similar conventional designs on state rural roads, and 69% less on local roads. Benefit Cost Ratios for state road designs were above 2 and close to 6 on local roads. Compact designs showed relative advantages in Safe System alignment and safety benefits, adequate approach speed management, and infrastructure cost reduction potential, while having comparable heavy vehicle performance, limited only by lower theoretical maximum capacity (generally not an issue on rural roads).

Conclusions: Implications for practice and policy

This evaluation confirmed compact roundabouts as a scalable, cost-effective Safe System solution for Victoria's high-speed rural network. The evaluation's recommendations support updating Victorian roundabout design guidance to encourage broader adoption of compact roundabouts and offer evidenced ideas for further roundabout cost reductions (Department of Transport and Planning 2021). Overall, single lane compact roundabouts offer an opportunity to treat a greater number of high-risk rural intersections than conventional designs with the same funds.

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Exploring current and future safety use-cases of connected vehicle data

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Abstract
Traditional road safety data collection methods, such as crash reports, roadside observations, and field-based traffic surveys, are often resource-intensive and often do not provide proactive insights into safety. Connected Vehicle (CV) data, sourced from large fleets in real time, offers a promising alternative for proactive and scalable safety analysis. This paper presents a comprehensive overview of the current uses and future potentials of CV data in road safety applications. A literature review provided a comprehensive list of existing applications of CV data in road safety, whereas structured consultations with 43 industry stakeholders across Australasia identified 85 future use cases at strategic, tactical, and operational levels. The findings highlight several underexplored applications that are not well represented in the existing literature, including enforcement camera location evaluation, fatigue monitoring, and driver–wildlife interactions. This research provides strong guidance on priority areas for future CV-based road safety investigations.

Background
Traditional road safety and traffic data collection methods are resource-intensive, time-consuming, and often introduce safety risks during the data collection processes. Safety analysis using the traditional data often do not allow prompt and proactive analysis of safety outcomes and taking corrective actions. As an alternative, Connected Vehicle (CV) data provides rich, detailed data for road safety applications, effectively overcoming the spatial and temporal limitations of traditional data sources. With industry providers such as CompassIoT, WirelessCar, and Wejo (defunct since June 2023) collecting and distributing CV data, the accessibility of CV data has significantly improved in recent years. CV data enables cost-effective, real-time insights into traffic operations, road safety, and mobility through detailed vehicle-generated information. While early CV research relied heavily on simulations (e.g., Zhao & Sun, 2013), the rapid increase in CV adoption has facilitated a shift toward real-world applications and large-scale trials (e.g., Ambros et al., 2019; Zhang et al., 2025).

CV data applications and trials include signal control and traffic flow optimisation, efficient ramp and lane merging, origin–destination analysis, and real-time alerts for first responders and many more. Although current CV penetration rates remain relatively low (approximately 2%), recent studies indicate an expanding, data-rich future, with annual growth rates ranging from 50% to 200% (Nassir et al., 2025). Furthermore, Argote-Cabañero et al. (2015) showed that actionable insights can be achieved with 3 – 5% penetration rate, ensuring that CV data will soon be a significant factor in road safety.

However, as CV data adoption accelerates, it is essential to critically assess CV data applications, their demonstrated value, future priorities, and limitations. Systematically identifying and evaluating use cases of CV data in road safety will help to guide current and future researchers and practitioners, ensuring focused efforts, efficient use of emerging data, and avoidance of redundant solutions.

Conference theme:
This study synthesises evidence from current research and practitioner insights on the growing capability of CV data to identify actionable outcomes for enhancing road safety, demonstrating its potential to address emerging safety challenges for a brighter future.

Method
A comprehensive literature review was conducted to identify current CV data applications published in peer-reviewed databases available on online platforms. In parallel, use cases presented on different CV data provider websites were examined to enable a comparison between peer-reviewed literature and practical applications implemented by various entities.

Building on the findings from the literature review and online analysis, three interactive workshops were conducted with 43 industry experts to explore perspectives on the future direction of CV data usage. Participants were recruited by contacting relevant organisations (e.g., transport departments, agencies, and consulting companies), outlining the study

objectives, and requesting nominations for appropriate representatives. Workshops 1 and 2 comprised government representatives from multiple Australian jurisdictions, with 21 and 13 participants respectively, while Workshop 3 involved 9 non-government industry experts.

All three workshops followed a similar structure of a 2-hour online setup. The participants were provided with some background information on CV data and the expected outcomes of the workshop at the beginning of each workshop. Following this introduction, participants were invited to propose potential application areas for CV data and to develop corresponding use cases through the use of an interactive online whiteboard. Use cases were gathered for four broad categories: speed management, road design, road development, and monitoring and evaluation.

Findings

The three workshops identified a total of 192 use cases, consisting of speed management (n=64), road design (n=62), road development (n=38), and evaluation and monitoring use cases (n=28). Even though the monitoring and evaluation category had the lowest number of use cases, further analysis of all use cases showed that some other use cases mentioned in the other categories had overlap with the monitoring and evaluation category.

The use cases generated through the workshops were subsequently analysed to identify and consolidate similar concepts across sessions. Following this process, a total of 85 unique road safety-related use cases were developed from the workshops collectively. This extensive list of use cases was further categorised using a thematic framework and a series of filters to assess their characteristics. Specifically, the use cases were classified according to their level of utilisation (strategic, tactical, and operational) and the extent to which they addressed Safe System pillars (covering all, multiple, or a single pillar). The number of use cases under each category is presented in Table 1.

Table 1. Number of use cases under each category

Level of utilisation	**Strategic**			**Tactical**			**Operational**		
Pillars of the Safe System	**All**	**Multiple**	**Single**	**All**	**Multiple**	**Single**	**All**	**Multiple**	**Single**
Speed management	0	2	3	0	9	5	1	3	5
Road design	0	3	3	0	5	5	0	7	0
Road development	1	7	0	0	3	0	0	2	2
Evaluation and monitoring	1	2	1	0	5	0	0	7	3
Total number of use cases		Strategic	23		Tactical	32		Operational	30

Overall, the CV data was deemed to be useful for various road safety applications. Among various applications, three key areas of CV data usage emerged as the most prominent: (i) intersection safety, (ii) driver behaviour and route choice, and (iii) identifying high-risk locations.

While the list of use cases generated through the workshops by experts mostly covered all use cases identified through online literature search, three additional use cases emerged exclusively from the literature. These three areas of CV data application are, (i) heavy vehicle fleet management, (ii) improving in-vehicle safety messages, and (iii) impact on transport from major concerts

Further, the refined set of 85 use cases obtained through the workshops offers deeper insight into the future direction of CV data applications. When classified by level of utilisation, the use cases demonstrate a balanced distribution across all three levels, comprising 23 strategic, 32 tactical, and 30 operational applications. In terms of alignment with the Safe System approach, three use cases addressed all pillars, 55 spanned multiple pillars, and 27 focused on a single pillar, with the speed pillar being the most frequently represented.

The three use cases covering all pillars of the safe system span the categories of speed management, road development, and monitoring and evaluation. Although some of these use cases, particularly at the strategic level, require further refinement to define a feasible scope, they provide clear and valuable direction for both researchers and practitioners. The three use cases are (i) network safety planning and building evidence for policy changes (s*trategic level road development), (ii) e*valuating the impact of policy change (s*trategic level evaluation and monitoring), and (iii) p*eriodic monitoring of speed on selected locations (annual KPI for strategies) (o*perational level Speed management).*

Additionally, the workshops identified six use cases that are not recorded in the literature: (i) selection of the most effective treatment types and devices for risky locations, (ii) overall effect of enforcement, (iii) informing current safety upgrade plans, (iv) identifying locations of animal strikes, (v) analysing growth areas and seasonal traffic changes, (vi) identifying how fatigue and other issues affect road safety. Similarly, many other interesting use cases were identified among the 85 use cases, which are not possible to be presented here due to page limits but will be discussed further at the conference. As future work, multiple use cases spanning across all categories (speed management, road design and development, and evaluation and monitoring) are currently being examined to assess the feasibility and applicability of CV data use, along with the strengths and limitations of the CV data in undertaking these use cases.

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Benefits to road safety

This work provides a clear and structured direction for leveraging CV data to improve road safety. The identified use cases offer practical and prioritised pathways for both researchers and practitioners to focus their efforts on impactful and feasible applications.

Implications for policy and/or practice

By highlighting key areas and underexplored opportunities where CV data can be used, this study supports more targeted, efficient, and evidence-based safety initiatives, ultimately helping stakeholders make better use of emerging CV data without duplicating existing efforts.

Conclusions

As CV data continue to grow, it is increasingly important that researchers and practitioners are equipped with clear guidance on how to apply these datasets effectively to maximise road safety. This study contributes to that need by providing a structured catalogue of road safety focused CV data use cases. To ensure long term value, future work should focus on implementing these use cases in real-world contexts and systematically documenting their outcomes, challenges, and insights. The use cases identified in this study will support the development of well-informed practices and provide future generations of researchers and practitioners with a comprehensive understanding of how CV data can meaningfully transform road safety and transport systems.

Acknowledgements

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Mainstreaming road safety in African National Development and Transport Planning

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Abstract
Road traffic injuries remain a critical public health and development issue across Africa, with rising fatalities and economic losses estimated at $162 billion annually. Despite global and regional initiatives, road safety is often overlooked in national development and transport plans. This study examines the extent to which road safety is integrated into national planning and highlights strategies for mainstreaming it effectively. Analysis of 30 African national development plans reveals that only 13 reference road safety in any meaningful way. Effective mainstreaming requires coordinated efforts: central ministries must recognize road safety's economic and social costs, transport ministries must align road safety with broader development goals, and lead agencies must advocate for systemic change. Prioritizing road safety within planning frameworks can drive targeted interventions, infrastructure investments, and policy reforms that enhance mobility and public health.

Introduction
Road traffic injury is a growing crisis in Africa, where fatalities continue to rise despite international commitments made. Road traffic injury is the third highest cause of death for Africans aged between 5 and 49 years, after only HIV/AIDS and tuberculosis, and the second highest cause of death and disability for Africans aged between 15 and 24 years, after only HIV/AIDS. The economic burden of road crashes is significant, yet national development plans rarely prioritize safety interventions. This study explores the gaps in road safety planning and proposes strategies for integrating road safety into national policies.

From Evidence to Action: Shaping a Brighter Future
National development plans are an important reference for government decision making in low and middle income countries. A review of these plans across 30 African countries revealed significant weaknesses in how road safety was being integrated into national planning processes, and examples where countries were capitalising on better integration of road safety into national development plans.

Methodology
30 African national development plans were reviewed and assessed for whether and how road safety was addressed. Case studies from Egypt, Gambia, Mali, and South Africa provided insights into policy implementation.

Results
Given the impact of road traffic injury on social and economic development across Africa, road safety has a disproportionately low profile in national development plans:

- There was no reference at all to road safety in 13 of the plans
- There was a cursory reference to the road safety problem in 4 of the plans
- There was some substantive reference to road safety in 13 of the plans.

The quality of the reference to road safety in the plans varied widely:

- Road safety is framed in several plans as something for which individual road users are responsible
- A much more holistic perspective on the problem is adopted in other plans, including:
  - Relating road safety to wider public health issues
  - Identifying institutional and planning issues for road safety, and
  - Setting specific safety outcome targets.

10 countries had a national road safety plan or strategy that is published online. There are a range of external, institutional and technical factors that make it difficult to link the success of strategy and planning processes with road safety improvement. Nevertheless, countries with dedicated road safety strategies such as South Africa and Gambia demonstrated better alignment of national development goals and national transport strategies with road safety goals, making it easier to integrate road safety investment into decision making.

Benefits to Road Safety

- Embedding road safety in national planning fosters coordinated policy action.
- Economic analyses suggest a high return on investment for road safety infrastructure.
- Improved road safety management leads to reduced fatalities and injuries.

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Implications for Policy and Practice

Government agencies with responsibility for road safety should ensure that they develop and maintain their own planning system, developed in a collaborative manner with road safety partner agencies. They must also ensure that road safety is given the priority that it warrants within the planning hierarchy of the Government.

Mainstreaming road safety into national development and transport plans requires responsibility to be assumed at three levels:

- Finance & Planning Ministries: Recognize road safety as a development priority
- Transport Ministries: Align transport investments with road safety strategies
- Road Safety Lead Agencies: Advocate for systemic road safety measures beyond behavioral interventions.

Conclusions

Road safety integration remains weak in African national transport, finance and development policies. Mainstreaming road safety requires a multisectoral approach where planning, transport, and safety agencies collaborate to embed safety into development frameworks. A structured policy response can drive substantial reductions in road traffic injuries and fatalities, contributing to sustainable mobility and economic resilience in Africa.

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Advancing Pedestrian Risk Assessment Through Empirical Bayes

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Abstract
Pedestrian safety in any built-up environment requires proactive, data-driven risk assessment to support effective intervention planning. Traditional crash-history analyses are inherently reactive and often unstable for rare severe outcomes, limiting their usefulness for forward-looking safety management. This study evaluates pedestrian risk assessment methodologies and identifies the Empirical Bayes (EB) approach as the most robust and practical method for network-level application. To demonstrate feasibility, prototype Safety Performance Functions (SPFs) were developed for intersections and mid-blocks in the Melbourne CBD using proxy exposure indicators where pedestrian counts were sparse. The EB-ready models showed behaviourally plausible relationships, with elevated risk associated with activity intensity and public transport environments. The proposed framework enables jurisdictions to identify high-risk locations, prioritise treatments, and strengthen evidence-based pedestrian safety strategies aligned with Safe System and Vision Zero objectives.

Introduction
Pedestrian safety remains a critical challenge in urban transport planning, particularly within dense central business districts where high pedestrian activity interacts with complex multimodal traffic operations. Traditional crash-based analyses are widely used by road agencies; however, these approaches are inherently reactive and often unstable for rare outcomes such as fatal and serious injuries (FSIs), limiting their value for proactive safety management and forward investment planning (Lord and Mannering, 2010). Recognising these limitations, this study was established to strengthen data-driven analytical capability and support more proactive pedestrian safety planning across Australian jurisdictions. This research contributes to that national initiative by advancing practical risk assessment methods suitable for network-wide application. In parallel, the growing availability of network data and analytical tools has created opportunities to transition toward predictive, risk-based approaches. Nevertheless, practitioners continue to face uncertainty regarding which analytical methods provide the most reliable and scalable basis for pedestrian safety decision-making in dense urban environments.

This study addresses that gap by systematically reviewing pedestrian risk assessment methodologies and identifying the most suitable approach for practical deployment. It then demonstrates a prototype implementation within the Melbourne Central Business District (CBD), illustrating how Empirical Bayes (EB) methods can be operationalised to support evidence-based pedestrian safety planning. This work was completed under Austroads Project SAG6371, Keeping People Safe When Walking—a multi-year program (2023–2026) supporting Australia and New Zealand to significantly reduce pedestrian trauma, aligned with Safe System ambitions for 2030 and toward zero by 2050. Within Stream 2, the Systemic Predictive Tools for Pedestrian Safety work package focused on developing methods and prototyping a tool to estimate pedestrian crash risk and exposure, and to calculate pedestrian SPIs suitable for routine reporting and monitoring.

Conference Theme
This paper aligns with the ARSC 2026 theme *"From Evidence to Action: Shaping a Brighter Future"* by translating advanced pedestrian risk modelling into a practical Empirical Bayes framework that supports proactive, data-driven Safe System decision-making and more targeted safety investment.

Review of Pedestrian Risk Assessment Methods
Pedestrian risk assessment methodologies vary considerably in terms of statistical robustness, data requirements, interpretability, and scalability for network-wide application. Selecting an appropriate method is therefore critical to ensuring reliable, evidence-based decision-making in pedestrian safety planning. Traditional descriptive and simple statistical approaches remain widely used due to their transparency and ease of communication. These methods are useful for high-level monitoring and reporting; however, they do not adequately account for key statistical issues such as regression-to-the-mean, exposure variation, and site-level heterogeneity. Consequently, their suitability for proactive network screening and investment prioritisation is limited. Surrogate safety measures (SSMs), including conflict indicators and harsh braking metrics, offer the advantage of providing earlier behavioural signals of emerging risk.

They are particularly valuable for short-term monitoring and post-implementation evaluation. Nevertheless, SSMs remain indirect proxies for trauma outcomes and are sensitive to assumptions regarding data penetration, threshold selection, and behavioural interpretation. As a result, their standalone use for strategic prioritisation should be approached with caution. Model-based approaches, particularly Safety Performance Functions (SPFs), provide a more rigorous statistical foundation by explicitly incorporating exposure and key roadway characteristics. SPFs enable prediction at sites with limited crash history and support more consistent network comparisons. However, SPF predictions alone do not fully utilise the observed crash experience at individual locations, which can contain important site-specific safety information. These limitations highlight the need for an integrated framework that combines the strengths of model-based prediction with observed crash history, motivating the adoption of the Empirical Bayes approach discussed in the following section.

Recommended Approach

Based on the findings from the literature, the Empirical Bayes (EB) method is the most effective and practical approach for pedestrian risk assessment (Hauer, 1997; Elvik, 2008). The EB method enhances predictive accuracy by combining historical crash data with Safety Performance Function (SPF) estimates, addressing key limitations of traditional crash-based analyses. This integration allows for a more reliable assessment of pedestrian crash risk while overcoming statistical biases, such as regression-to-the-mean effects.

The EB method is particularly advantageous because it:

- Mitigates random variability in crash data, reducing the risk of misleading conclusions.
- Provides a statistically robust framework for risk prediction and countermeasure evaluation.
- Supports evidence-based decision-making, ensuring safety investments are directed toward interventions with the highest potential impact.

Proposed Prototype Tool for Strategy and Action Plan Design

To demonstrate practical feasibility, a prototype EB-ready modelling framework was developed for the Melbourne CBD. The analysis covered signalised intersections and mid-block segments within the Melbourne CBD. After data validation, the modelling samples comprised approximately 118 intersections and 208 mid-blocks. Multiple datasets were integrated, including:

- pedestrian crash outcomes
- traffic exposure (AADT)
- infrastructure and geometric attributes
- land-use and employment indicators
- demographic context
- operating speed environment

Explicit pedestrian count models were initially explored using a GEE negative binomial framework. However, extremely sparse count coverage (≈5% intersections; <2% mid-blocks) resulted in unstable and unreliable predictions.

Consistent with international practice in data-constrained environments, the final SPFs adopted proxy exposure indicators, including employment intensity, residential context, and proximity to public transport hubs. This approach provided substantially improved scalability while maintaining behavioural plausibility.

Model development

A structured workflow was applied, incorporating collinearity screening, staged Poisson estimation, overdispersion testing, evaluation of zero-inflated alternatives, engineering sense checking, and assessment of Empirical Bayes (EB) parameter readiness.The preferred model forms are summarised in Table 1.

Table 1: Summary of developed pedestrian risk models

Location	Outcome	Model form	Key predictors
Intersection	FSI	Poisson	Left-turn lanes, AADT, number of dwellings
Intersection	Casualties	Negative Binomial	Intersection type, presence of bus lane, hospitality employment
Mid-block	FSI	Poisson + length offset	Within 250 m of a public transport hub, total employment, demographics
Mid-block	Casualties	Negative Binomial + length offset	Public transport hub proximity, public transport lanes, total employment, mean speed

Key Findings

Across both intersections and mid-blocks, the prototype models demonstrated internally consistent and behaviourally credible relationships. Locations characterised by higher activity intensity—particularly employment-dense precincts and public transport catchments—consistently exhibited elevated pedestrian risk. Conversely, more structured and

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channelised intersection environments were associated with lower severe outcomes within the highly controlled CBD context. At mid-block locations, proximity to major public transport hubs emerged as one of the strongest predictors of FSIs (IRR ≈ 2.2), reinforcing the importance of transit precincts as priority environments for intervention. Overall model diagnostics indicated acceptable goodness-of-fit and stability for EB application.

Empirical Bayes Implementation

The Empirical Bayes (EB) framework was implemented to produce statistically improved estimates of pedestrian crash risk by combining model-based predictions with observed crash history. Following development of the preferred Safety Performance Functions (SPFs) for intersections and mid-blocks, EB estimates were derived using standard weighting procedures that balance the long-term expected crash frequency from the SPF with the site-specific observed crash counts. This approach corrects for regression-to-the-mean and stabilises risk estimates, particularly at locations with sparse severe crash records. Prior to EB application, model diagnostics confirmed acceptable goodness-of-fit, parameter stability, and behavioural plausibility, ensuring the SPFs were suitable for EB integration. In practical terms, the EB outputs were used to support network screening and prioritisation within the Melbourne CBD. Locations with higher EB-adjusted expected crash frequencies were identified as candidates for further investigation and potential treatment. The implementation demonstrated that EB can be operationalised using proxy-based exposure models where pedestrian count data are limited, providing a scalable pathway for agencies to transition from reactive crash analysis toward proactive, evidence-based pedestrian safety management.

Practical Application and Policy Implications

The Empirical Bayes (EB) method plays a crucial role in pedestrian safety planning, road safety investment, and policy development by enabling data-driven, proactive decision-making. It is effectively applied at both strategic and tactical levels, involving:

- Data Collection & Calibration to develop and refine Safety Performance Functions (SPFs).
- Risk Assessment & Prioritisation to identify high-risk locations and guide intervention planning.
- Countermeasure Evaluation to assess safety measure effectiveness and refine strategies.
- Integration with Emerging Data Sources for enhanced predictive accuracy using connected vehicle data and real-time monitoring.

By incorporating EB-based risk assessment into policy and practice, jurisdictions can shift from reactive crash analysis to proactive risk mitigation. This method supports:

- Improved Risk Identification before severe crashes occur.
- Optimised Safety Investments by prioritising high-impact interventions.
- Evidence-Based Decision-Making that ensures countermeasure effectiveness.
- Enhanced Post-Implementation Evaluation to refine future safety programs.

By leveraging the EB method, jurisdictions can develop effective pedestrian safety action plans, ensuring safer environments and aligning with Vision Zero objectives.

Conclusions

A robust pedestrian safety strategy requires moving beyond purely reactive crash analysis toward predictive, exposure-sensitive methods. This study demonstrates that the Empirical Bayes approach provides the most balanced combination of statistical rigour, practical scalability, and policy relevance. The Melbourne CBD prototype confirms that EB-ready pedestrian SPFs can be developed using proxy exposure indicators where pedestrian counts are sparse. The resulting models provide stable and behaviourally credible estimates suitable for network screening and evaluation. With continued data improvement and integration of emerging mobility datasets, EB-based pedestrian risk assessment is well positioned to support next-generation Safe System implementation across Australian jurisdictions.

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Connected vehicle data for safe system speed management evaluation

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Abstract
Achieving Safe System speed outcomes requires monitoring approaches that are both analytically robust and operationally scalable. While pneumatic tube counts provide high-quality point measurements, they lack temporal continuity and network coverage. Connected vehicle (CV) data offers significant promise; however, questions remain regarding its validity, representativeness, and suitability for formal evaluation. This paper presents a structured framework for operationalising Compass IoT connected vehicle data within a practitioner-focused dashboard across four Victorian Local Government Areas (LGAs) - Mildura, Stonnington, Mitchell, and Murrindindi - and demonstrates its application through a Difference-in-Differences (DiD) evaluation of Mildura's 40→30 km/h speed limit trial. Results show strong directional agreement between CV data and tube counts, statistically significant reductions in speeds attributable to the intervention, and meaningful declines in estimated probability of fatal or serious injury (Pr(FSI)) for pedestrians and bicyclists. The study provides a practical and technically robust pathway for embedding connected vehicle analytics into Safe System speed management.

Background
Speed is a primary determinant of crash severity, particularly for vulnerable road users. Traditional monitoring methods such as pneumatic tubes remain the benchmark for site-specific measurement but provide limited spatial and temporal coverage. Connected vehicle data offers continuous network-wide insight but requires validation and operational frameworks before widespread adoption.

To address this gap, the Department of Transport and Planning (DTP), in partnership with Mildura Rural City Council, City of Stonnington, Mitchell Shire Council, and Murrindindi Shire Council, implemented a program to test Compass IoT data and develop a practitioner-ready dashboard. The completed Mildura 40 to 30 km/h trial provides the primary case study for evaluation.

Conference theme
This paper aligns with the ARSC 2026 theme, "From Evidence to Action: Shaping a Brighter Future," by translating connected vehicle data into practical, decision-ready intelligence. Through multi-LGA deployment and a Mildura Difference-in-Differences case study, the research demonstrates how data-enabled evaluation can directly support real-world speed management and harm reduction for Victorian road users.

Method

Multi-LGA analytical framework
The program adopted a structured multi-stage framework comprising:
- validation of connected vehicle (CV) data
- development of a practitioner dashboard
- integration of advanced safety indicators
- quasi-experimental evaluation

The four participating LGAs served complementary analytical roles:
- Mildura - primary validation and evaluation case study
- Stonnington - metropolitan sufficiency assessment
- Mitchell - higher-volume rural validation
- Murrindindi - lower-volume rural stress test

Sample size diagnostics across LGAs indicated that CV data is generally robust for network and corridor monitoring, although caution is required for highly localised rural analysis where penetration levels are lower.

Estimation of probability of fatal or serious injury (Pr(FSI))
To complement conventional speed metrics, the evaluation incorporated an estimated probability of fatal or serious injury (Pr(FSI)). In the urban LGAs - particularly Mildura - the metric reflects the risk faced by pedestrians and bicyclists, who represent the most vulnerable road users in these environments.

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The approach (Sobhani, 2025) uses the observed mean operating speed derived from connected vehicle data at both link and network levels and maps these speeds to established pedestrian injury risk relationships. This method is grounded in evidence showing that the likelihood of severe pedestrian injury increases rapidly with impact speed (Davis, 2001), with VicRoads SSIAT research supporting application to cyclists where dedicated curves are unavailable (Logan et al., 2019). Pr(FSI) is intended as a screening-level harm indicator rather than a substitute for crash-based safety modelling and is most valuable for early evaluation, Safe System communication, and network screening.

Difference-in-Differences evaluation design

To quantify the causal impact of the 40 to 30 km/h intervention in Mildura, a quasi-experimental Difference-in-Differences (DiD) framework was adopted. This approach compares the change in outcomes at treated sites before and after the intervention with the corresponding change at matched control sites, thereby controlling for common temporal trends. Treated road segments comprised streets subject to the 30 km/h implementation, while comparable untreated segments within the Mildura network were used as controls. The analysis was undertaken at the network level using aggregated connected vehicle speed metrics. Generalised linear regression technique has been utilised to conduct the analysis. Robust standard errors were applied, and the primary outcomes assessed were mean speed and 85th percentile speed.

Findings

Validation of connected vehicle data against tube counts

To assess the reliability of connected vehicle data for speed monitoring, CV-derived metrics were compared with co-located pneumatic tube observations in Mildura. The comparison focused on directional consistency in mean and high-end speeds. Table 1 presents the comparison results.

Table 1. Comparison of tube and connected vehicle speed metrics (Mildura)

Measure	Tube Before	Tube After	CV Before	CV After
Mean speed (km/h)	29.7	29.1	18.4	15.6
85th percentile speed (km/h)	36.6	35.7	29.8	26.4

Although absolute speed values differed - reflecting known methodological differences between free-flow tube measurements and all-state connected vehicle observations - the direction and relative magnitude of change were consistent across both data sources (Sobhani, 2024). This supports the suitability of connected vehicle data for network monitoring and before–after evaluation when interpreted appropriately.

Difference-in-Differences evaluation (Mildura case study)

The DiD model indicated statistically significant reductions in both mean speed and high-end speeds following the intervention. Table 2 presents the DiD results.

Table 2. Difference-in-Differences results (Mildura network level)

Outcome	Estimated Change	95% CI	Significance
Mean speed	−1.3%	−1.9% to −0.7%	Statistically significant
85th percentile speed	−1.2%	−1.8% to −0.5%	Statistically significant

These findings confirm that the observed reductions are attributable to the intervention rather than background trends.

Connected vehicle dashboard indicators

The CV dashboard provided additional behavioural and risk insights beyond the DiD analysis.
Table 3 summarises the key dashboard indicators for Mildura. Because the Pr(FSI) estimates are driven by observed mean speeds, the reductions indicate a meaningful shift in the injury risk profile for pedestrians and bicyclists in the Mildura urban environment.

Table 3. Key behavioural and risk indicators from CV dashboard (Mildura)

Safety indicator	Before	After	Change
Mean speed (km/h)	18.6	17.4	−6.2%
85th percentile speed (km/h)	29.9	26.1	−12.7%
% > 30 km/h	43.9%	34.5%	−21.5%
Harsh braking	13.3%	6.9%	−48.0%
Pr(FSI) – pedestrians & bicyclists	6.9%	6.0%	−12.8%

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Discussion

The findings demonstrate that connected vehicle data can be operationalised within a Safe System framework that satisfies both practitioner usability and analytical rigour.

For practitioners, the dashboard enables continuous network monitoring, earlier evaluation of interventions, and harm-focused performance tracking. For modellers, the study confirms that CV data can support quasi-experimental inference and surrogate safety analysis when appropriate calibration and aggregation are applied.

However, several limitations remain, including the limited number of control sites, penetration variability, and reliance on literature-based severity relationships. Accordingly, CV-derived risk metrics should currently be interpreted as complementary indicators rather than replacements for crash-based evaluation.

Benefits to road safety

This work demonstrates that connected vehicle data can provide reliable, near–real-time insight into speed behaviour and associated harm risk at network scale. The strong directional agreement between connected vehicle data and tube counts in Mildura further supports the reliability of CV analytics for practical speed management applications. Furthermore, the Mildura case study showed statistically significant reductions in mean and high-end speeds, accompanied by an estimated reduction in Pr(FSI) for pedestrians and bicyclists. Collectively, these findings indicate that CV-enabled monitoring can support earlier detection of safety benefits, improved targeting of speed management interventions, and more responsive Safe System delivery.

Implications for policy and/or practice

The results support the integration of connected vehicle analytics into routine speed management and program evaluation frameworks. Road agencies can use CV dashboards to complement traditional tube data, particularly for network-wide monitoring and short-term post-implementation assessment. The evidence also supports incorporating harm-based indicators such as Pr(FSI) into performance reporting to better align speed management with Safe System objectives. Continued calibration with crash data is recommended to further strengthen policy confidence and support broader deployment across jurisdictions.

Conclusions

This research provides a cohesive pathway for embedding connected vehicle analytics into Safe System speed management. Across the four-LGA program, CV data demonstrated strong scalability for monitoring, while the Mildura DiD case study confirmed its capability for quasi-experimental evaluation. With continued calibration and integration with crash data, connected vehicle analytics are well positioned to support next-generation road safety monitoring across Australasia.

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Getting real action on road safety

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Abstract
In recent decades a significant proportion of road safety spending has been directed at regional and rural and high speed road environments . To the extent this has been successful, the more challenging work is now around urban and lower speed (50kmh and under) environments that comprise the bulk of our roadspace. In these areas Road safety has not materially improved and is, in the case of pedestrian and cycle FSI, either flat or worsening. Many road safety professionals already know the evidence of the treatments required to tackle these urban areas. The harder part is getting action. This interactive workshop is a practical persuasion lab for people who want action on safer speeds, better crossings, safer vehicle design, fairer road space and better access to daily needs. Participants will work in roundtable groups to craft and test tailored pitches for the different stakeholders who influence decision-making. We'll use a structured worksheet to identify what matters to those stakeholders, what barrier needs to be overcome, and who is best placed to deliver the message. Pitches will be judged for persuasiveness. Delegates will leave with practical tools, sharper messages and ideas they can apply immediately to their work in policy, advocacy, project delivery and community engagement.

Introduction

The evidence is clear
The evidence on effective road safety interventions is well established. Yet deaths and serious injuries remain unacceptably high, and people outside vehicles continue to bear a substantial share of road trauma. In the most recent national data, people on foot accounted for 13% of road deaths and 7% of road injury hospitalisations, while people on bicycles accounted for 3% of road deaths and 17% of road injury hospitalisations, highlighting the scale of harm experienced by people outside vehicles. (BITRE 2025a. Tables 10 and 11)

The evidence on what works is strong. Safe speed management, low and sloped front bonnets, more crossings, fairer road space allocation and better access to daily needs are central to reducing exposure to harm and supporting safer, healthier and more liveable communities.

Evidence of the negligible impact of 'last-mile' changes on journey time, of the success in real terms of these changes and the relative speed of rollout in other countries when compared to infrastructure-heavy solutions is also abundant.

Example 1: Speed limits are shown to work
In Wales, where a national default urban speed limit of 20mph (30kmh) was introduced in September 2023, the country has recorded at 28% reduction in casualties on streets where the speed limit changed.
Austroads' most recent update to speed management states that confirms that the survivability threshold is 30 kmh where vehicles interact with people walking or riding, is in line with the 2020 UN Stockholm Declaration on road safety. (Austroads 2025). Austroads also reports each 5 kmh reduction in urban speeds results in a 26 % reduction in fatal and injury crashes.

Example 2: Vehicle design is changing, with deadly results
Higher and more vertical vehicle front ends are associated with significantly greater pedestrian injury severity and fatality risk, including in real-world crash analysis of 18,000 crashes (Hu et al, 2024) The Insurance Institute for Highway Safety reports that vehicles with front bonnets taller than 101cm were 45% more likely to kill a person on foot, compared to a bonnet height of 76cm (IIHS, 2023).

In Australia, a decade ago, passenger sedans made up 44.6% of new vehicle sales, when the top-selling vehicle was a Toyota Corolla with a bonnet height of 70cm, with a sloped profile. By 2025 passenger sedans had dropped to 13.0% of new vehicle sales while SUVs made up 60.7%. The top selling car in Australia is now the Ford ranger, with a blunt-shaped bonnet height of 125cm. (FCAI, 2026, 2025). This 45cm increase in height raises pedestrian fatality risk by up to 145% due to the higher risk of deadly force to the head and neck.

We need more persuasive storytelling
Unfortunately, the evidence about what works simply isn't getting cut-through in Australia, resulting in billions of dollars being spent on road safety that isn't getting us towards Vision Zero. Measures that improve safety often encounter resistance because they challenge established assumptions about driver convenience, community acceptance,

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network performance, and what level of harm is treated as normal. This shows that road safety is not simply a technical problem. It is also a communication problem. Change depends on how evidence is framed, who delivers the message, which values it connects with, and whether it responds to the priorities and blind spots of different stakeholders. (Hayhoe 2013, Satell 2019).

Australia also suffers from the cognitive biases of familiarity bias and insufficient adjustment – that is, we know how to build shoulders and what changes they bring, it we are unfamiliar with slow speed (and familiar with recent, high profile opposition). We also base our expectations of what is possible on the ststus-quo ante, preferring "the evidence of our eyes" and the lessons of our English-speaking sphere.

This workshop addresses that implementation gap directly. It empowers 'first movers' to lead on the necessary change. It is designed for road safety practitioners, policy-makers, advocates and communicators who already know the evidence and want to become more effective at turning that evidence into persuasive action.

Conference theme

This workshop directly addresses the ARSC2026 conference theme, From Evidence to Action: Shaping a Brighter Future, by focusing on one of the sector's most persistent challenges: how to turn strong road safety evidence into decisions, policies and projects that are actually delivered.

The workshop responds to the conference theme in three ways. First, it starts from the premise that the evidence base is already strong. Second, it focuses on why action still stalls, including institutional inertia, system bias, political caution and communication failures. Third, it gives delegates a practical method for tailoring messages to different stakeholders so they can better educate, persuade and mobilise leaders, influencers and communities. This aligns closely with the conference emphasis on education, persuasion, messaging and engaging key groups. Rather than revisiting familiar evidence in depth, the workshop asks delegates to use it. The result is a practical, collaborative session built around persuasion, implementation and action.

Facilitator: Sara Stace

Sara Stace is Director of Cities at Vivendi Consulting and is on the board of the World Cycling Alliance. She has worked in local, state and federal government, corporate and the not-for-profit sector. Sara excels at translating evidence into policy, project delivery and advocacy. Her work spans safer speeds, street design, active transport planning, business cases, policy reform and public communication. Sara is highly experienced in facilitating workshops to align diverse groups around evidence-based action. She brings a practical understanding of how road safety decisions are shaped, resisted and progressed across different parts of the system. This workshop draws on Sara's cross-sector experience to provide delegates with practical tools for communicating evidence in ways that build urgency, cut through competing narratives and result in implementation.

Workshop leader: Marc Lane

Marc Lane is a Director of Place Strategy at Vivendi Consulting and former president of WalkSydney. As an elected councillor he brings a unique perspective on what gets cut-through with local government. With a background in state government where he led the development of the NSW Government's Movement and Place framework. Marc brings strong technical expertise across a range of issues related to land use, public space, streets. His work focuses on helping clients navigate complex policy, place and delivery challenges to achieve safer, more connected and more liveable outcomes.

Interactive Workshop format

This workshop is designed as a practical persuasion lab rather than a passive discussion session. Delegates will work in groups to translate road safety evidence into tailored messages for different stakeholders in the system. The worksheet will provide a structured path from evidence to action by prompting groups to identify the stakeholder's priorities, the system barriers or assumptions that need to be addressed, and the messenger most likely to be effective. Groups will then convert that thinking into a short verbal pitch. The emphasis is on applied message development, not abstract discussion. Delegates will test how evidence can be framed to create urgency, respond to bias and increase the likelihood of action in real-world settings.

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Table 1. Interactive workshop format

Format	Activity	Lead	Timing	Description
Presentation	Introduction, implementation gap and approach	Sara Stace, Marc Lane	15 mins	Brief framing of the problem and gap. Focus is on practical ways to communicate evidence effectively to different stakeholders, drawing from Satell on systems change and Hayhoe on values-based communication and persuasion.
Interactive	Workshop brief	Sara Stace	3 mins	Each table is assigned a stakeholder group and receives a worksheet to guide writing a tailored message and pitch.
Interactive	Table work: key messaging development	All tables, Marc and Sara to assist	30 mins	Tables work through the worksheet, identifying what matters to that stakeholder, and what will matter to get them onside.
Interactive	Table work: pitch writing	All tables	5 mins	Each table writes a 1 to 2 minute pitch based on its discussion and message framework.
Discussion	Table pitches	All	15 mins	Each table presents its 1 to 2 minute pitch to the room.
Discussion	Judge's verdict	Judge	2 mins	Judge provides brief feedback on which pitch was strongest and why.
Presentation	Wrap-up	Sara Stace	5 mins	Facilitator summarises key insights and practical applications for delegates.

Interactive Workshop outcomes and actions

This workshop is designed to produce practical outcomes. Delegates will leave with a clear understanding of how to translate road safety evidence into persuasive messages tailored to different stakeholders, and how to respond to the biases and barriers that stall implementation. Expected outcomes include improved capability in framing evidence for different stakeholders, stronger understanding of why proven interventions often fail to gain traction, and a set of practical message frames and pitch approaches generated during the workshop.

A post-workshop summary of key insights and example message frames could be prepared and shared publicly through an accessible online summary or practitioner-focused resource. This would allow delegates to see how their contribution informed a practical output and would extend the value of the session beyond the conference.

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Driver decision-making during Tropical Cyclone Alfred

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Abstract
In March 2025, South-East Queensland experienced its first landfalling cyclone in 50 years: Tropical Cyclone Alfred. Research on driving during extreme weather has largely focused on evacuation decisions, with less attention given to situations where evacuation is unlikely. We analysed data from 319 participants describing their driving decisions across the cyclone's lifecycle. The nature of trips people took changed as the cyclone approached, crossed, and passed the coastline. Despite the cyclone making landfall at a lower intensity than projected, road infrastructure was significantly affected. Participants reported hazards including floodwater and non-functioning traffic lights, which caused confusion at intersections. The only significant predictor of driving was perceived danger: individuals who believed driving in a cyclone was more dangerous were less likely to drive. These findings highlight the importance of communicating the risks of driving during and after extreme weather events, which can be used to shape interventions and road safety policy.

Introduction
Climate change is increasing the severity and frequency of extreme weather events, creating growing risks for transport systems and road users (CSIRO & Bureau of Meteorology, 2024). Storm-related events such as cyclones, hurricanes, and tornadoes can make driving hazardous by reducing visibility and tyre traction, damaging infrastructure, and obstructing roads with debris or floodwater. In Queensland, 840 fatal crashes between 2001 and 2023 occurred during adverse weather conditions, accounting for 14.1% of all fatal crashes (Stainer et al., under review). Despite these risks, research on travel behaviour in extreme weather has largely focused on evacuation decisions (Bowser & Cutter, 2015; Norris et al., 1999; Wong et al., 2020), with limited attention given to everyday driving when evacuation is unlikely. Understanding how and why people choose to drive before, during, and after extreme weather events is important for improving emergency management, infrastructure resilience, and public safety messaging, particularly as climate change exposes new regions to unfamiliar hazards. In March 2025, Tropical Cyclone Alfred provided an opportunity to study driver behaviour around a real Cyclone event, in an area of Queensland that has less recent exposure to such conditions.

Cyclone Alfred formed in the Coral Sea on 22 February 2025, intensified to Category 4, and later weakened before making landfall north of Brisbane on 8 March as a Category 2 system, rapidly downgrading to a tropical low. Although weakened, the event caused substantial impacts across southeast Queensland, including wind gusts exceeding 100 km/h, widespread power outages, and prolonged heavy rainfall. Some areas recorded more than 1000 mm of rain over seven days, leading to flash flooding and major riverine flooding across parts of Queensland and northern New South Wales. Severe coastal erosion and large swell conditions also affected the region, with economic damages projected to exceed AUD $1.2 billion.

This study contributes to our understanding of driving during extreme weather events by examining driving behaviour across the lifecycle of a cyclone event in South-East Queensland, Australia. Participants reported their travel patterns: (1) throughout the 2 days before the cyclone was due to cross the coast, (2) during the actual impact as it made landfall (downgrading from a Category 2 cyclone to a tropical low), and (3) in the day following landfall. This continuous monitoring approach provides rare insights into the way driving behaviour and decision making adapts to dynamically changing weather conditions. Specifically, the study documented the number of trips participants made, purposes motivating travel, and challenges reported in using the roads.

Conference theme
The 2024 State of the Climate report outlined the changing environmental conditions in Australia, including a projection for more intense weather events in the future (CSIRO & Bureau of Meteorology, 2024). Currently, we know little about how drivers will respond to this changing climate. Evidence from Cyclone Alfred suggests that drivers may severely underestimate the risks of driving during, or after, extreme weather events. Our work begins to understand decision-making processes around extreme weather events, which can be used to shape future interventions and road safety policy.

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Methods

Participants.

We asked 367 drivers (recruited from a university research pool and the wider community) to tell us about their driving behaviour during the cyclone. Of the sample, 42 participants were removed due to only having a learner's class driving license (and could therefore not independently make decisions to drive without a supervisor), and a further 6 participants were removed as they did not report driving "daily", or "a few times per week", leaving a final sample of 319 participants. All participants provided informed consent prior to completing the survey and the study was approved by the University Human Research Ethics Committee (Ref: 2025/141).

Driver survey

An online survey was developed to examine motivations, experiences, and decision-making related to driving during Cyclone Alfred, as well as general attitudes toward driving in cyclones. Participants first reported demographic information including age, gender, employment, postcode, licence class, driving experience, and typical driving frequency. They then rated how dangerous they believed driving in a cyclone to be and identified perceived risks (e.g., strong winds, flooding, reduced visibility, fallen trees or powerlines), with an option to provide additional responses. Participants described any driving undertaken during Cyclone Alfred (6th-9th March), including the day, destination, and reason for travel. The survey also assessed willingness to drive during cyclone warnings, confidence in driving under such conditions, and motivations or precautions associated with cyclone-related driving. Participants reported whether they had previously ignored extreme weather warnings, and the survey concluded with open-ended questions about hazardous driving conditions experienced following the cyclone and any additional reflections on driving in cyclone conditions.

Procedure

Participants who signed up to the study were sent the link to complete the survey. Data collection was terminated on 23rd of April 2025; 45 days after the weather event had made landfall.

Results

Number of journeys per day

Of the 319 participants, 94 (29.5% of the sample) indicated they had driven at some point between Thursday 6th and Sunday 9th March. Of these, 9 participants did not provide a date aligned to the driving activity undertaken. Of the 85 participants that identified the days they drove, only 6 participants (1.9%) drove every day of the cyclone, 20 participants (6.5%) drove on three of the days, 23 participants (7.4%) drove on two days, and 36 participants (11.6%) drove on only one day. A curvilinear trend was observed in driving activity (Figure 1, left panel), with a reduction in the number of people who drove from Thursday 6th through to Saturday 8th March (when the Cyclone made landfall and downgraded to a Tropical Low), followed by an increase on Sunday 9th March. In examining combinations of days that participants drove (Figure 1, right panel), the most common combination was to drive on Thursday, Friday and Sunday (2.2% of the sample).

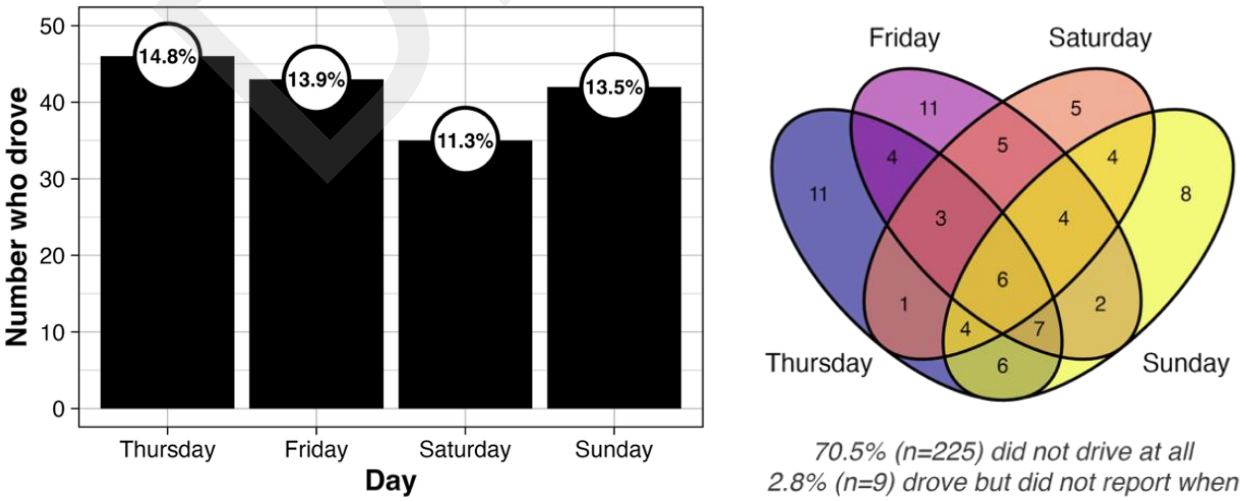

Figure 1. Number of people who drove on each day (left panel) and combinations of days (right panel).

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Predicting who drove *during* the cyclone

The overall model revealed that higher perceived danger was associated with lower odds of driving at some point during a cyclone, $OR = 0.50$, 95% CI [0.34, 0.71], $p < .001$. None of the demographic variables (i.e., age, gender, marital status, dependents, license type) were significant predictors of driving behaviour, all p's > .323.

Reasons for driving *during* the cyclone

During the build-up to the cyclone's projected landfall, most trips were classified as activities to get 'Food and Supplies' (Thursday 30.0%, Friday 40.4%). On Friday there was also an increase in the number of trips undertaken for the purpose of 'Friends and Family' (26.9%), which was the most common reason for travel on Saturday (23.1%), demonstrating a shift towards providing emergency support while the cyclone made landfall. On Sunday, the most common trip reason was Work (31.2%), revealing a rapid community return to normal.

Challenges for driving *after* the cyclone made landfall

Participants reported a range of hazards when driving after the cyclone had passed. The most common issue was debris on roads (48.3%), followed by flooding or floodwater (39.2%). Traffic light outages due to power loss were also reported (10.0%), creating confusion at intersections. Less frequently mentioned hazards included road closures or detours (6.0%), reduced visibility or heavy rain (4.7%), downed powerlines (4.7%), and observing crashes (0.6%). Overall, responses indicate that debris and flooding were the primary post-cyclone driving hazards.

Benefits to road safety

This study provides new insights into how driving behaviour changes before, during, and after an extreme weather event. The findings show that perceived danger strongly influences decisions to drive, suggesting that improving public risk perception may help reduce unnecessary travel during hazardous conditions. The results also identify key periods of increased risk, including the immediate aftermath when debris, flooding, and infrastructure failures are common. Understanding these patterns can help road safety agencies anticipate driver behaviour and target safety messaging during the most critical stages of a cyclone.

Implications for policy and/or practice

The findings highlight several implications for emergency management and road safety policy. Because perceived risk was the only significant predictor of driving, communication strategies should focus on clearly conveying the dangers of driving throughout the entire lifecycle of extreme weather events, including the post-impact period. The prevalence of last-minute supply trips also reinforces the importance of preparedness campaigns, such as encouraging earlier preparation to reduce non-essential travel as conditions worsen. Further, the persistence of hazards after the cyclone underscores the need for continued public messaging that discourages unnecessary travel while road networks remain compromised.

Conclusions

This study provides the first empirical evidence of how everyday driving behaviour changes before, during, and after a tropical cyclone makes landfall in Australia. Driving decisions varied across the lifecycle of the event, with most trips occurring during the preparation phase and shortly after the cyclone passed and were primarily influenced by perceived danger rather than demographic factors. Reports of widespread hazards after the cyclone highlight that road safety risks persist even once a storm has weakened. These findings emphasise the importance of effective risk communication, preparedness, and infrastructure recovery to reduce road safety risks during extreme weather events.

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Fixed driver-distraction and seatbelt camera trial on a Victorian motorway

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Abstract
The Victorian Government is expanding its distracted driving and seatbelt (DDS) camera program as part of the Road Safety Strategy 2021–2030. Following a parliamentary recommendation to expand mobile phone and seatbelt enforcement, a Proof of Concept trial tested DDS technology as a fixed installation on a CityLink gantry in 2025. The trial assessed technical feasibility, integration, image quality, and offence prevalence. Cameras operated reliably with high-resolution images in all conditions. Over the 30 day trial, 862,737 vehicles were assessed and 13,827 offences detected (1.6%), most commonly portable device use, followed by driver and passenger seatbelt offences. Fixed cameras provided more consistent performance than relocatable systems due to stable mounting and permanent power. Findings show fixed DDS cameras are technically viable and suitable for highspeed motorways where locating relocatable units is difficult. The trial supports expanding fixed DDS enforcement to reduce distracted driving, improve seatbelt compliance, and reduce road trauma.

Background
As part of Victoria's Road Safety Strategy 2021-2030 (Department of Transport, 2020), the Victorian Government announced funding in December 2020 to deliver a fleet of new generation road safety cameras that can detect illegal portable device use, the absence of seatbelts and other offences. Portable device use while driving and other illegal activities described as "Distracted Driving Offences" cause drivers to take their eyes and concentration off the road ahead, increasing risks of collision, trauma, and death. Distracted driving and seatbelt (DDS) cameras were introduced in March 2023, mounted on relocatable trailers (State Government of Victoria, 2023).

In 2024, the Parliamentary Inquiry into The Impact of Road Safety Behaviours on Vulnerable Road Users (Legislative Assembly Economy and Infrastructure Committee, 2024) recommended that: "*The Victorian Government continue the implementation of the Mobile Phone and Seatbelt Detection Camera technology… (p xxii)".*

A Proof of Concept (POC) trial of DDS was conducted to assess the deployment of DDS technology as fixed-location enforcement systems on gantries, with the goal of making enhancements for potential permanent installation. The POC aimed to evaluate the feasibility of fixed-location deployment of the DDS technology through an initial trial at the "M2 Citylink Gantry" in partnership with the private motorway operator. This POC aimed to assess practical implementation, identify technical constraints, assess the integration and scalability of the DDS system and measure the prevalence of portable device and seatbelt offences.

Conference theme
The DDS POC trial addresses the theme From Evidence to Action: Shaping a Brighter Future by collecting evidence to support the use of fixed DDS cameras on infrastructure on Victoria roads, in order to expand the current DDS program, with a view to reduce portable device use and seatbelt misuse and ultimately reduce road trauma.

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Method

Aside from introducing actuated mounting brackets, no significant hardware changes were made to the system used in the Relocatable DDS program.

The camera provider worked with the private motorway operator and the relevant Victorian Government department to find an appropriate site and create permits to conduct works for the proof of concept trial. The area around Moreland Rd, Brunswick was chosen for the trial based on the relatively high rate of portable device use infringements observed. Several specific locations were assessed to determine a suitable location based on:

- Eliminating the possibility of interference with any other technological systems on the gantry
- Walkway access to the Gantry from a secured location, e.g., a locked gate
- Simple availability of power via the motorway operator's infrastructure
- Space available for the camera provider's interconnecting Electrical / Comms Cabinet
- Over Lane mounting space available for DDS Camera Systems

The DDS cameras were installed on 9th April 2025, and test data was collected until 27th April and used to optimise the Artificial Intelligence (AI) model for detecting offences. Cameras were mounted above Lanes 1 and 2 (refer to Figure 1). Cameras mounted on top of the gantry obtained an overhead view through the windscreen and cameras mounted on the bottom rail of the gantry obtained a view of the face and the licence plates. The 30-day POC trial of the DDS cameras was conducted from 28th April to 27th May 2025, and the cameras were subsequently removed on 24th June 2025.

During the trial, the AI model detected offences which were flagged and then verified by a human. No infringements were issued for offences during the trial period.

Figure 1. Image showing the DDS cameras mounted on the existing gantry above Lanes 1 and 2
(Source: Jenoptik)

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Findings

Throughout the POC trial the technology performed reliably with consistent uptime and limited technical issues. The image quality of the system was excellent and resulted in high fidelity enforcement images. The image quality produced from the fixed system was clear and of high resolution in all weather and lighting conditions.

An average of 461 offences was detected per day, and the offence rate per vehicle was 1.6%. The most common offence was touching a portable device, followed by driver seatbelt offences, portable device resting offences and passenger seatbelt offences. A vast majority of the seatbelts worn incorrectly were positioned under the arm, or behind the back, there were also instances where the seatbelt was held out / away from the body, not properly fastened.

Table 1. Number of vehicles assessed and offences detected during the 30-day POC trial

	Lane 1	Lane 2	Total
Number of vehicles assessed	443,205	419,532	862,737
Driver seatbelt offences	1,526	1,304	2,830
Passenger seatbelt offences	832	831	1,663
Portable device resting	1,187	1,308	2,495
Portable device touching	3,957	2,882	6,839
Total	7,502	6,325	13,827

No environmental impacts on performance were identified. Compared to the relocatable DDS cameras, the fixed system allowed a greater assessment of seatbelt offences because the face camera is mounted at a higher vantage point, so the seatbelt of the vehicle can be very easily seen. Both the relocatable and fixed systems provide high resolution clear images but the fixed system offers greater consistency due to stable mounting positions which should deliver more reliable performance than the relocatable solution. In addition, a fixed installation will have a permanent mains power supply which will eliminate any degradation of performance around battery life, solar panel issues or generator faults.

Benefits to road safety

Enforcement is effective in changing behaviour. Reducing portable device use will reduce the occurrence of crashes while reducing seatbelt non-compliance will reduce the severity of injuries if a crash occurs. This is of particular benefit on motorways where the probability of injury after a crash is higher due to the travel speeds.

Implications for policy and/or practice

The implications of this trial for policy and practice are that there is clear evidence that the installation of fixed DDS cameras on Victorian motorway infrastructure (gantries) is technically and operationally feasible and the trial showed that driver-distraction and seatbelt offences are prevalent on these types of roads. Considering the difficulties with finding appropriate locations for relocatable DDS cameras on inner urban motorways, the use of fixed DDS cameras provides a solution for enforcing portable device use and seatbelt misuse on high-speed roads.

Conclusions

The POC trial of fixed DDS cameras on a motorway gantry was successful and provides the evidence to further explore expanding the program by adding fixed DDS cameras. Long term maintenance requirements must be factored into site selection to ensure ongoing support is feasible without incurring excessive costs or logistical effort.

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Under the radar: ADAS priorities during vehicle purchase and driver behavioural adaptation

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Abstract
Advanced Driver Assistance Systems (ADAS) have demonstrated meaningful crash-reductions in the Australian vehicle fleet. To maximise these benefits, it is important to understand how drivers prioritise ADAS when purchasing a vehicle and how they understand, experience and adapt to the technology in practice. This study reports findings from a national online survey of 842 Australian drivers with ADAS-equipped light vehicles no more than five years old. While drivers tended to prioritise overall safety ratings over individual ADAS features at purchase, over half reported deliberately choosing an ADAS-equipped vehicle. Most denied changes to their driving when ADAS was enabled, yet some acknowledged specific adaptations when prompted, including reduced situational awareness and increased engagement in secondary tasks. Many drivers reported positive experiences, particularly relating to safety, comfort, and reduced stress. These findings suggest that ADAS may operate "under the radar" for many drivers, highlighting opportunities to support confident and informed use.

Introduction
ADAS are a broad class of vehicle technologies that support road safety through warnings, automated vehicle control, or both (Rajan & Öther-Gee, 2022). Evaluation studies conducted by the Monash University Accident Research Centre and others internationally and others internationally have established significant real-world safety benefits for key systems, including autonomous emergency braking (AEB), lane keeping assist (LKA), and electronic stability control (ESC). For example, LKA has been associated with a 16% reduction in all casualty crashes and a 22% reduction in fatal and serious injury run-off-road and head-on crashes in Australia (Newstead et al., 2023). in Australia Modelling full fitment of various ADAS across the Australian light vehicle fleet has projected reductions of between 1% and 9% of annual serious or fatal injury crashes, depending on the system (Budd & Newstead, 2021). While the safety benefits of ADAS are well established, their introduction also brings shifts in the driving task that can affect a driver's behaviour.

ADAS can fundamentally change the driving task (Heikoop et al., 2019). This is because ADAS may introduce new demands or reduce demands to a level where the driver is no longer actively engaged. These shifts can lead to unintended changes in driver behaviour. In a seminal paper, this was termed *behavioural adaptation* and defined as any change in behaviour due to the presence or use of ADAS that is unintended or unexpected by system designers (OECD Scientific Expert Group, 1990). Behavioural adaptation can include over-reliance, distraction, skill degradation, loss of situational awareness, and increased risk-taking (Brookhuis et al., 2001; Kim & Oviedo-Trespalacios, 2025).

Much of the existing research on behavioural adaptation has relied on objective measures, such as instrumented vehicles or driving simulators. Less is known about the extent to which drivers self-report changes in their driving behaviour and experiences when using ADAS, and about the broader context of how ADAS is perceived as a safety consideration at the point of vehicle purchase. This study examined these questions using a national survey of drivers in Australia.

Conference theme
This work addresses the ARSC 2026 theme "From Evidence to Action: Shaping a Brighter Future" by presenting survey evidence on how drivers in Australia perceive and interact with ADAS. The findings identify opportunities for safety messaging and driver education to enhance the driver's awareness of ADAS road safety benefits and potential inappropriate impacts on behaviour.

Method
This study was part of a broader mixed-methods project examining ADAS understanding and behavioural adaptation among drivers in Australia (Stephens et al., 2025). This presentation discusses the online survey component which was conducted in 2023. The survey was hosted on the Qualtrics platform and participants were recruited via paid Facebook advertising, posters displayed on the University campus and social media. Participants were eligible if they drove a vehicle no more than five years old with at least one ADAS system, drove at least once per week, were aged 18 years or older, and resided in Australia. Ethics approval was obtained from Monash University (ID: 37309).

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The online survey consisted of 96 items: the majority were fixed response items, others permitted free text answers. Participants ranked eight vehicle safety considerations in order of importance: current safety rating, vehicle size and structure, internal design, car seat fitting, number and location of airbags, ADAS technologies, familiarity with the make or model, and other. They also indicated whether they had deliberately selected a vehicle equipped with ADAS and, if so, their reasons.

Behavioural adaptation was assessed using nine items on a 5-point agree-disagree scale. Items asked whether, when ADAS was enabled, drivers: responded more slowly to hazards, drove at higher speeds, had reduced situational awareness, checked blind spots less frequently, relied on ADAS, followed vehicles more closely, engaged more in secondary tasks, perceived driving as less risky, or changed lanes more frequently. Responses were collapsed into three categories (agree, neutral, disagree) for descriptive presentation.

Drivers were also asked about how their driving changed when ADAS was enabled. These items captured perceptions about own or passenger safety, perceived level of comfort, concentration required for driving, level of stress, enjoyment of driving, and positive interactions with others. Response options were: increased, neutral or decreased.

Results

After exclusions for incomplete responses and ineligible vehicles, 842 responses were retained. Participants had an average age of 52 years (SD = 16, range 18-90), 88% identified as men and 12% as women. Participants drove an average of 20,900 km per year and their primary vehicle was on average 2.2 years old (SD = 1.67).

ADAS as a vehicle safety priority

Over half of the sample (51%) reported deliberately choosing a vehicle equipped with ADAS. Among those who had done so (multiple response options were possible), the most common reasons were: ADAS came as standard fitment (62%), a desire to improve safety (49%), interest in the latest technology (30%), familiarity from a previous vehicle (11%), and a prior crash avoidance experience (7%).

When asked to rank the importance of ADAS relative to other vehicle safety features, participants ranked the vehicle's overall safety rating (ANCAP) as the most important factor, above vehicle size and structure, and well above ADAS specifically. Only 12% of participants ranked ADAS as their most important vehicle safety consideration. This suggests that most drivers may perceive ADAS as a feature of a safe vehicle rather than as a distinct safety technology (see Figure 1). If this is the case, they may be less likely to learn how each system works, understand its limitations, or know when it's active.

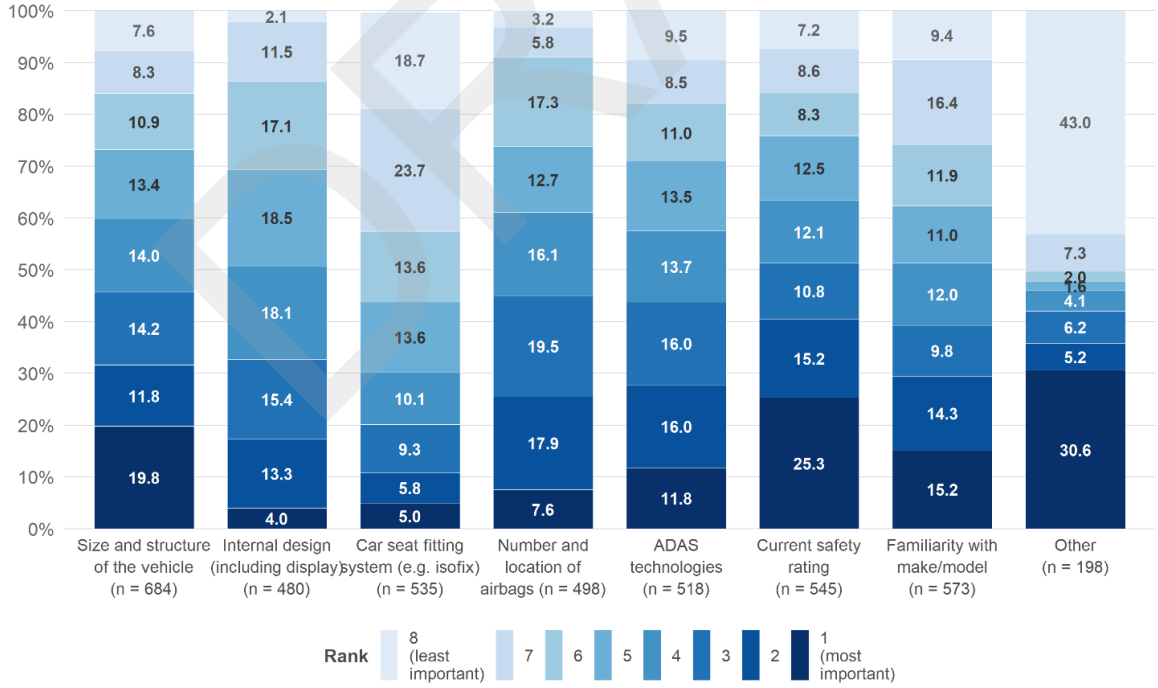

Figure 1. Ranking of importance of vehicle safety features

Behavioural adaptation

Most participants reported positive changes when ADAS was enabled in terms of perceived increased safety (63%) and comfort (54%) and many also noted increases in their enjoyment of driving (36%) and decreases in stress while driving (33%). Most (73-84%) also disagreed that they drove at higher speeds, made more frequent lane changes, or maintained shorter following distances when ADAS was enabled. However, a notable proportion acknowledged changes consistent with behavioural adaptation. Specifically, 28% agreed they conducted less frequent head checks, and 21% agreed they engaged in secondary tasks more frequently. This pattern indicates that while drivers do not report broad changes in vehicle control behaviours, when thinking about more specific behaviours some degree of self-reported adaptation is evident, particularly in attentional engagement. These are changes that drivers may not spontaneously recognise

Benefits to road safety

These findings point to two interventions which could strengthen the road safety outcomes of ADAS. First, increasing the visibility of ADAS as a safety technology at the point of purchase may help some drivers engage more actively with information about how these systems work. Second, the fact that drivers acknowledge behavioural changes when prompted suggests that guided reflection could support greater awareness of shifts in attention or engagement while driving. Together, these areas offer possible avenues for supporting the safe and effective use of ADAS.

Implications for possible interventions

Two tentative implications emerge from these findings. First, safety messaging at the point of purchase could present individual ADAS systems more clearly as safety-relevant features, drawing on existing evidence to help consumers understand their contributions to road safety. Second, driver education and training programs might consider incorporating content on behavioural adaptation to ADAS. This could use prompted rather than open-ended approaches to help drivers recognise subtle changes in their own behaviour that may otherwise go unnoticed. These approaches could complement existing efforts to support safe vehicle use.

Conclusions

This survey of 842 Australian drivers suggests that ADAS may operate “under the radar” at two points in the driver experience. At the point of purchase, many drivers appear to place greatest importance on the vehicle’s overall safety rating, ranking it above vehicle size and structure and well above individual ADAS features. This means many acquire ADAS through standard fitment rather than deliberate feature selection. This may influence understanding and use. During use, most drivers feel their overall driving remains consistent when ADAS is enabled. However, a notable proportion acknowledged specific adaptations, particularly in relation to attentional engagement. These insights highlight opportunities to enhance the benefits that ADAS can provide by strengthening driver awareness of the systems.

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How lane departure crashes change with traffic volume

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Abstract
Road crashes along high-speed regional and remote roads continue to represent a substantial issue. The prevalence of different lane departure crash types changes with traffic volume, with head-on crashes becoming more prevalent than run-off road crashes as volumes increase. This study was undertaken to replicate the findings of a previous New Zealand study for the South Australian context. This study showed that as traffic volumes increased, the rate of head-on crashes increased at a rate greater than that of run-off road crashes to the extent that a cross-over point is reached where head-on crashes become the dominant cause of harm. Benefit-cost ratios were also calculated for different road safety infrastructure treatments, with the results showing treatments targeting head-on crashes achieving economic viability at traffic volumes higher than for those targeting run-off road crashes.

Introduction
Road crashes present a substantial problem for Australia, leading to 1,186 deaths in 2023 (BITRE, 2025). Two-thirds of this harm occurred in regional and remote areas, with the rate of crashes per population in these areas far exceeding that of major cities (BITRE, 2025). Regional and remote areas are typified by high-speed roads, with speed limits often of 100 km/h or more. The level of road safety infrastructure along these roads is improving but leaves a substantial gap between the current state and the Safe System objective of a road transportation system free of serious injury and death (Woolley et al., 2018).

Because of the vast lengths of roads in regional and remote areas and the limited budget that can be spent on improving them, road safety planners need to prioritise both where money is spent and on what it is spent. Typically, regional and remote roads have a high incidence of single vehicle run-off road and head-on crashes (Tan et al., 2023). These crashes, collectively known as lane departure crashes, typify the target of much road infrastructure investment along these roads. A key challenge for road safety planners is understanding which of these two crash types should be targeted. While different road safety infrastructure treatments can mitigate both crash types, they often target one or the other. For example, wide centrelines and median road safety barriers target head-on crashes while roadside barriers and shoulder sealing target run-off road crashes.

The prevalence of head-on and run-off road crashes changes with traffic volume. As highlighted by the crash rate versus traffic volume graph presented in NZTA (2011), the rate of head-on crashes tends to increase with volume until it surpasses that of run-off road crashes. In New Zealand, the point this occurs was estimated to be approximately 6,000 vehicles per day, AADT (NZTA, 2011). This threshold represents a crossover where the treatment of head-on crashes becomes a priority concern over run-off road crashes. While the actual threshold will depend on a variety of factors and vary between locations, such a threshold is useful for understanding what types of crashes should be targeted and therefore what forms of treatments should be prioritised. This is especially meaningful for locations where the recent crash history is not extensive enough to paint a clear picture as to the relative incidence of each crash type.

Tracing its routes back to the New Zealand *High-risk Rural Roads Guide* (NZTA, 2011), the aforementioned crash rate versus traffic volume graph was reproduced in multiple Austroads publications (Robertson et al., 2024) and therefore serves as potential evidence for decision makers in both Australia and New Zealand. Given the age and origins of this evidence, there remains a need to reproduce such a study for the South Australian context and to extend the work towards estimating high-level benefit-cost ratios for familiar road safety infrastructure treatments in-line with these findings.

Conference theme
This study aligns to the conference theme by providing empirical evidence for road safety planners to better understand the crash mitigation needs of high-speed regional and remote roads. While the context of the study is South Australia, the results can be generalised to other areas of Australia typified by similar roads.

Method
The objective of this study was to 1) estimate, over a range of traffic volumes, the rate at which different lane departure crashes occur on high-speed regional and remote roads in South Australia, and to 2) extrapolate from these trends

benefit-cost ratios for familiar road safety infrastructure treatments aimed at mitigating lane departure crashes. The method used to achieve these objectives is defined below.

South Australian crash data for 2019-2023 were obtained through Data SA (2025). Using QGIS, this dataset was joined with traffic volume data and road safety infrastructure location data provided by the Department for Infrastructure and Transport (DIT). Owing to the different time periods in which the data was obtained, a limitation of the study was that certain relationships, such as the traffic volume or presence of certain infrastructure at the time of a crash, could not be guaranteed. This limitation was minimised by sourcing datasets that temporally overlapped.

The joined dataset was cleaned to remove crashes that did not conform to the types under investigation. Crashes labelled as *hit fixed object*, *roll over* and *left road – out of control* were retained as run-off road crash type data points, while crashes labelled as *head-on* were retained as head-on crash type data points. The joined dataset was limited to DIT-managed roads with a speed limit of 80 km/h or more, with an undivided carriageway, and within the rural area. Additionally, only crashes with at least one fatal or serious injury (FSI, serious injury defined as an injury requiring hospital admission) were considered. A total of 10,263 km of roads and 547 FSI crashes were considered in the study. The crash data was skewed towards lower volume roads, with 50% of crashes occurring on roads of 1,000 AADT or less and 97.5% on roads with 5,000 AADT or less.

The joined dataset was processed using a negative binomial method. The inputs to the model comprised crash counts of FSI crashes aggregated at the road segment level. This method was preferred over the non-linear regression "banding" method apparently used by NZTA (2011), as over-dispersion within the South Australian dataset meant that any fit of regression model was highly dependent on the chosen banding width used to aggregate data across the road network within specified traffic volume bands. The negative binomial method removed the need for such banding of the data.

Benefit cost ratios (BCRs) were calculated for six different road safety infrastructure treatments aimed at mitigating harm from lane departure crashes. Three were aligned to treating run-off road crashes and three aligned to treating head-on crashes. BCR calculations for each road safety infrastructure treatment type were undertaken using a different portion of the road network, as road lengths showing the existence of said treatment type were excluded from the calculation to avoid double-counting the effect of each treatment. Benefits were calculated using willingness to pay values provided by DIT and crash modification factors from Beer et al. (2021). Road safety infrastructure treatment unit costs were provided by DIT.

Results

The results from this study showed an increasing trend in the rate of both run-off road and head-on crashes as traffic volume increased. Similar to NZTA (2011), a cross-over point was seen where the rate of head-on crashes overtook that of run-off road crashes (Figure 1). This is to be expected, as a higher traffic volume increases exposure to head-on crashes in the event of a lane departure to the right. However, the shapes of the regression curves presented in Figure 1 differed between the current study and that from NZTA (2011). This can be partially explained by the different methods employed in each study. The results from this study showed a rapid increase in crash rate, especially for head-on crashes, as traffic volumes increased beyond 6,000 AADT. This can be explained by the low number of crashes on roads above circa 5,000 AADT.

The results from the BCR analysis showed that the BCR of all treatments increased along with traffic volume, though the rate of this increase was markedly different for each treatment type. Treatments that favoured the mitigation of run-off road crashes tended to achieve a BCR of 1.0 earlier. Surprisingly, centreline audio tactile line marking (ATLM) achieved a BCR of 1.0 at a higher traffic volume than roadside barriers, which were substantially more expensive to install. While median barriers were the most expensive treatment considered, they achieved a BCR of 1.0 at just over 4,000 AADT. Wide centrelines, which only mitigate the likelihood of head-on crashes, did not achieve a BCR of 1.0 within the volume range considered in this study.

Benefits to road safety

This study shows that the type of lane departure crash risk changes with traffic volume. At lower volumes, run-off-road crashes are more common, while at higher volumes, head-on crashes become more dominant. Since head-on crashes are generally more severe, this shift indicates that higher-volume rural roads present greater injury risk from opposing traffic conflicts.

Policy implications

The results provide a practical way to help prioritise road safety treatments using traffic volume. Lower-volume roads are better targeted with treatments aimed at run-off-road crashes, while higher-volume roads should focus on preventing head-on crashes.

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Conclusions

The results of this study confirm the findings from NZTA (2011) that there exists a traffic volume at which the rate of head-on crashes is likely to exceed that of run-off road crashes, though it also differs in the details of when this occurs. Extending beyond this, the results also provide evidence for when certain road safety infrastructure treatments may be considered. While the results of this study are general in nature, they may allow road safety planners to more readily identify road safety infrastructure treatments useful for mitigating harm from lane departure crashes along high-speed road environments.

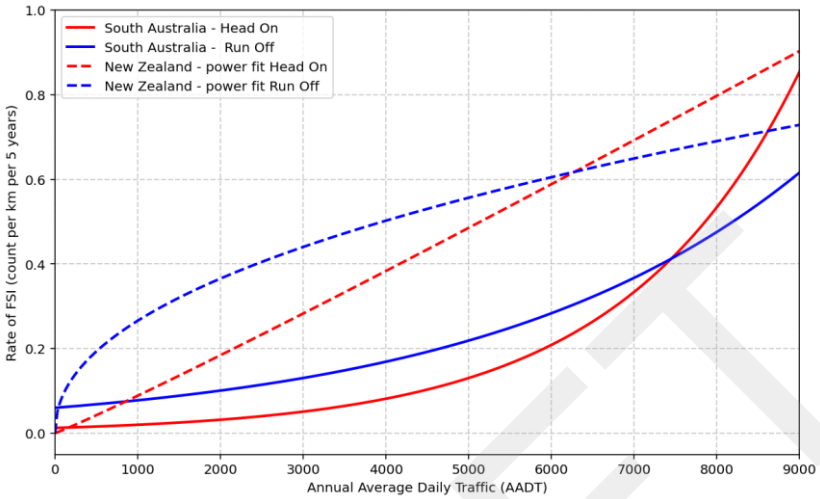

Figure 1. Crash rate versus traffic volume regression curves for South Australia (solid curves) and New Zealand (broken curves) – the latter is reproduced from NZTA (2011)

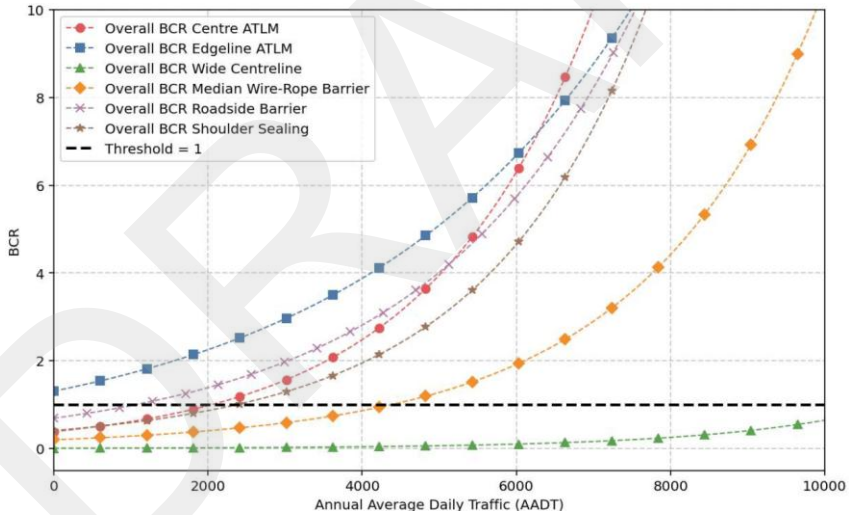

Figure 2. Benefit-cost ratio versus traffic volume regression curves for South Australia

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Braking the Cycle – safer drivers on Queensland roads

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Abstract
The PCYC Braking the Cycle (BTC) program has created a unique sequence of induction onboarding for participants and volunteer mentors prior to any practical driving hours. The connection made with the young person provides a driving experience that suits their level of experience, educational, communication style and cultural safety. Mentors are assessed and provided with in-depth mentor training modules, provided with in vehicle experience and a maintained vehicle. Partnering with professional driving school providers rounds out the individualised experience for the participant as they achieve the necessary steps towards the 100 hours of practical driving. The number and nature of traffic offences and road crashes of BTC were compared with a matched control sample. These groupings demonstrate involvement in the BTC program reduced subsequent traffic histories in terms of infringements and crashes. Ongoing analyses will assess if participation in the BTC positively impact driving behaviour through reductions in traffic offences and crashes (Lewis et al., 2024)

Background
Young drivers remain one of the most vulnerable road user groups in Queensland. Recent data indicates that young people are disproportionately represented in serious road crashes, highlighting the ongoing need for targeted road safety education and support during the learner and provisional licensing stages (RACQ, 2025). Although the implementation of the graduated driver licensing (GDL) system in Queensland has contributed to improved road safety outcomes for young people, it has also created significant barriers for those who lack the social support systems and financial resources required to obtain the mandated supervised driving hours (Schoots, 2025).

PCYC Queensland's Braking The Cycle (BTC) program was established to address these barriers by supporting young people to obtain supervised driving hours while developing safer and more responsible driving attitudes and behaviours. In addition to providing registered and insured vehicles and trained volunteer mentors to fulfil the supervising driver role, BTC is underpinned by the delivery of road safety education designed to support safer decision-making and driving practice. BTC Volunteers are intrinsically motivated to assist the young persons successfully achieve a Provisional licence as it both ensures that the learner driver is demonstrating safer tendencies on the road, but also for the changes a Provisional licence can make in the young persons life. The BTC program actively encourages outcomes such as improved access to employment or further education, reduced risk of social exclusion and positive connections between participants and community members. None of which is possible without the BTC Mentors and the experience they bring to the program.

In 2024 the MAIC QUT Road Safety Research Collaborative published their initial findings in the comparison of BTC participants to a control group regarding occurrence of traffic infringements and/or traffic crashes matched by age, gender, location and date of licensure.
These findings demonstrated that BTC participants were involved in fewer occurrences than the matched control group (Lewis et al., 2024)

So what creates this difference ? The BTC program over a course of 13 years has created a dedicated approach to the onboarding, education and supervision of young persons based upon their specific need both within and external to the program.

Conference theme
This work demonstrates how gained evidence coupled with stakeholder consultation and collaboration can be translated into practical supervision of BTC participants. The program has consistently focused on initiatives that improve engagement among young learner drivers. The ongoing education of the BTC staff and volunteer mentors has reduced aspects relating to barriers to driver licensing, adolescent brain development, and effective learning and retention of information. However, recognising that research and evidence alone does not change behaviour, the project has prioritised consultation and co-design with the people directly involved in the program, including participants, program staff, volunteer mentors, road safety organisations and agencies, and academic researchers. This work highlights the importance of collaboration when it comes to translating evidence into practical action to improve road safety outcomes.

Project description

The Braking the Cycle program pairs volunteer mentors with learner drivers who need support in completing their logbook hours but whom have challenges such as a lack of vehicle at home, lack of a supervisor in the family group, language other than English or other barriers.
To achieve the best possible outcome and retain both volunteers and participants in the program PCYC has developed an established guideline for participant entering and progressing through the program towards the 100 hours required to undertake the Provisional Driving Licence exam.

Contained within the program is the requirement to adhere to aspects such as a hazard perception test and the required hours of aspects such as night driving, as contained within the Department of Queensland. Beyond that the PCYC has established a dedicated online learning modules and session plans to maximise the content and progression of the participant.

Partnering with the MAIC QUT Rod Safety Research Collaboration a study named “Outcome evaluation of the PCYC’s ‘Braking the Cycle’ (BTC) Learner Driver Mentor Program” was published, authored by Professor Ioni Lewis, Catherine Kennon and Sonali Nandavar.

Results

The research project by Lewis, Kennon and Nandavar compared traffic offence and crash data history of consenting BTC participants with a control group of individuals matched by age, gender, location and date of licensure. Results indicated that the number of BTC participants had incurred significantly fewer traffic offences and were involved in fewer crashes. (Lewis et al., 2024)

The aspect that BTC participants demonstrated less occurrences in both categories could therefore be a reflection on the programs structure and provision of set tasks beyond the simple completion of 100 hours. \
The use of a volunteer mentor base, in standard vehicles ensures that the program does not directly compete with or recreate the services of a professional driving school. What the program does provide however is a stable learning environment with trained mentors, creating a opportunity for learners to engage with a supervisor with knowledge and experience above that of a family member or friend.

Benefits to road safety

This BTC program contributes to improved road safety outcomes by increasing engagement with structured road safety education among young learner drivers, who remain some of the most vulnerable road users across Australia, and are identified as having barriers in their life to traditional supervisory situations.

By including the road safety education element of the BTC program within the overall concept of 100 hour logbook supervision, the program improves engagement for young people who may experience challenges and create poor life choices such as driving unlicenced.

The program also promotes personal accountability by ensuring participants book and attend sessions. Failure to follow PCYC policy can see drives reworked or the participant required to complete additional online road safety education sessions. This accountability provides PCYC with a platform to engage on a social platform with the learner driver. Opportunities for feedback and reflection within the program support participants to consider how key road safety concepts apply directly to their own driving behaviours, reinforcing the development of safer attitudes and driving behaviours on the road.

Using such research evidence and stakeholder consultation the BTC Program has the ability to implement practical road safety education tools, and through this additional education beyond simple supervision of hours BTC strengthens the capacity of the learner driver mentor program to equip young drivers with the knowledge, awareness, and responsibility required to become safer road users.

Implications for policy and/or practice

The BTC program has provided support to over 8,000 participants during operation, with approximately 600 volunteer mentors active at one time across Queensland. With almost a 50% success rate in obtaining Provisional Licences highlight the importance of designing road safety education that is accessible, engaging, and responsive to the needs of diverse learner driver populations.

The incorporation of practical, evidence based education beyond the text based format is attractive to BTC participants who engage from various support networks, are from CALD backgrounds, from First Nations backgrounds and could be disengaged from standard learning environments.
The project also highlights the value of consultation and co-design in developing effective road safety content. Engaging program mentors and participants in the design of the on road sessions can support other BTC locations across

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the state when encountering similar situations with geographical distance, mentor support, weather conditions and societal trends amongst young drivers.
The findings suggest that structured learner driver support should embed road safety education as a core component of LDMP programs, with an emphasis support beyond simple supervision. Such approaches have the potential to promote safer driving attitudes and behaviours, increase meaningful experience by at risk youth, and contribute to broader aspects of the PCYC through return patronage or volunteerism.

Conclusions

The redevelopment of the Braking The Cycle program demonstrates the value of practical road safety education initiatives.
Through a continual assessment process involving program participants, staff, volunteers and other road safety stakeholders, the BTC program has developed an interactive, supportive, practical based system to supervise participants across logbook hours.
Early results indicate a substantial reduction in traffic offences and traffic crashes when BTC participants re compared to a control group.

Future work will focus on ongoing monitoring of these infringements and crash data, as well as continued refinement of the practical session based engagement of participants. Participant and mentor feedback is critical to maintain the relevance and validity of the program when focused upon the needs and trends of young drivers. This is particularly relevant to BTC communities faced with cultural situations, socio-economic challenges, geographical challenges and access to external services such as driver testing facilities.

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From evidence to engagement: developing road safety education for learner drivers

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Abstract
How do you turn road safety evidence into learning that young drivers actually engage with?
For more than 14 years, PCYC Queensland's Braking the Cycle program has supported vulnerable young people to obtain a driver licence and develop safer driving behaviours. Yet its road safety education component relied heavily on text-based content and long outdated videos, leading to low engagement among participants. Through extensive consultation with learners, mentors, program staff, road safety organisations, and researchers, BTC redesigned its approach to road safety education. The result was a new interactive learning platform built using insights from consultation, adolescent brain development research, and best practice in learning retention. In the first three months following its launch, participants completed almost 750 hours of road safety education, highlighting how consultation and evidence-based design can transform engagement with road safety learning.. This presentation shares how evidence, co-design, and innovation can reshape road safety education and improve engagement with vulnerable learner drivers.

Background
Young drivers remain one of the most vulnerable road user groups in Queensland. Recent data indicates that young people are disproportionately represented in serious road crashes, highlighting the ongoing need for targeted road safety education and support during the learner and provisional licensing stages (RACQ, 2025). Although the implementation of the graduated driver licensing (GDL) system in Queensland has contributed to improved road safety outcomes for young people, it has also created significant barriers for those who lack the social support systems and financial resources required to obtain the mandated supervised driving hours (Schoots, 2025).

PCYC Queensland's Braking The Cycle (BTC) program was established to address these barriers by supporting young people to obtain supervised driving hours while developing safer and more responsible driving attitudes and behaviours. In addition to providing registered and insured vehicles and trained volunteer mentors to fulfil the supervising driver role, BTC is underpinned by the delivery of road safety education designed to support safer decision-making and driving practice. Road safety education has always been a core element of the BTC program, although historically this component has relied heavily on the use of lengthy text-based resources and outdated, long-form video materials. This approach presented challenges for meaningful engagement, particularly for vulnerable young people who may experience literacy difficulties and disengagement from traditional learning environments. These challenges highlighted the need to redevelop the road safety education component to better align with contemporary learning practices and the needs of BTC participants, with the aim of improving engagement and accessibility, as well as supporting more meaningful learning outcomes.

Conference theme
This work demonstrates how research evidence and stakeholder consultation and collaboration can be translated into practical road safety education initiatives that improve engagement among young learner drivers. The redevelopment of the BTC road safety education platform has been informed by evidence relating to barriers to driver licensing, adolescent brain development, and effective learning and retention strategies. However, recognising that research and evidence alone does not change behaviour, the project has prioritised consultation and co-design with the people directly involved in the program, including participants, program staff, volunteer mentors, road safety organisations and agencies, and academic researchers. This work highlights the importance of partnership and innovation when it comes to translating evidence into practical action to improve road safety outcomes.

Project description
In 2024-2025, PCYC Queensland undertook a redevelopment of the road safety education component of the BTC learner driver mentor program. The project aimed to improve accessibility, engagement, and learning outcomes for program participants, many of whom face social and educational barriers to traditional learning approaches.

The redevelopment was guided by a consultation and co-design approach, recognising that the most effective solutions are informed by the experiences of those participating in or facilitating the program. Extensive consultation was undertaken with program participants, volunteer mentors, and program staff across multiple locations throughout

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Queensland to better understand the learning needs, barriers to engagement, and practical considerations for delivering road safety education within a learner driver mentor program. A combination of consultation methods was used to maximise engagement and accessibility, including facilitated workshops, traditional paper-based feedback activities, and digital consultation tools such as Poll Everywhere. These multi-faceted approaches enabled participants to share ideas and perspectives and prioritise learning needs in real time, while also facilitating input from stakeholders across the entire state without requiring extensive travel resources.

Broader consultation was also undertaken with road safety organisations and agencies, funding partners, and academic researchers to ensure alignment with current road safety evidence and best practice. Insights from these consultations were combined with research relating to adolescent brain development, learning retention, and effective road safety education approaches to inform the development of a new interactive, technology-enabled road safety education platform for BTC participants, launched on December 1 2025.

Prior to launch, the platform was trialled with program participants from multiple BTC sites across the state to assess usability, engagement, functionality, and relevance of the content. Feedback gathered from trial participants was reviewed and used to refine the platform and learning modules before full implementation. Additional feedback was also sought from program staff and volunteer mentors to evaluate the practicality and effectiveness of the platform. This iterative process ensured the final platform reflected the needs of all stakeholders.

Findings

The redevelopment of the road safety education component of BTC resulted in the launch of a new, interactive learning platform in December 2025. The platform was designed to improve accessibility and engagement by incorporating shorter learning modules, interactive activities, and reduced reliance on text-heavy resources. The platform also places increased responsibility on participants to actively engage with the learning as part of their licensing journey, reinforcing that learning to drive is not only a rite of passage, but also a significant responsibility for the safety of themselves and others on the road. The platform also incorporates opportunities for participants to reflect on key learnings throughout the modules, supporting deeper engagement with the content and demonstrating that participants are retaining meaningful road safety knowledge.

The early uptake of the platform, with almost 750 hours of road safety education completed within three months of launch, highlights the potential for interactive and technology-based learning to increase participation in road safety education. Importantly, the consultation and co-design process ensured the resources were specifically tailored to the needs of the program's target cohort, including young people who may face literacy or engagement barriers in traditional education forms.

These findings reinforce the importance of collaboration, consultation, co-design and evidence-informed design in strengthening road safety education initiatives. Programs that integrate research evidence with stakeholder input may be better positioned to improve engagement and learning retention, further contributing to safer driving behaviours and attitudes among young drivers.

Benefits to road safety

This work contributes to improved road safety outcomes by increasing engagement with structured road safety education among young learner drivers, who remain some of the most vulnerable road users across Australia, and who may otherwise face barriers to accessing traditional learning formats. By redesigning the road safety education element of the BTC program to incorporate interactive, technology-enabled learning and reduced reliance on text-heavy comprehension materials, the program improves accessibility and engagement for young people who may experience literacy challenges or disengagement from traditional education approaches.

The platform also promotes personal accountability by encouraging participants to actively engage with road safety learning as part of their progression through the learner driver journey. Opportunities for reflection within the modules support participants to consider how key road safety concepts apply directly to their own driving behaviours and develop road safety toolkits, reinforcing the development of safer attitudes and driving behaviours on the road.

By translating research evidence and stakeholder consultation into practical road safety education tools, BTC strengthens the capacity learner driver mentor programs to equip young drivers with the knowledge, awareness, and responsibility required to become safer road users.

Implications for policy and/or practice

The findings from this project highlight the importance of designing road safety education that is accessible, engaging, and responsive to the needs of diverse learner driver populations. Programs that support young people to obtain a driver licence should incorporate evidence-informed education approaches that move beyond traditional text-based learning formats, particularly where literacy barriers may limit engagement. Furthermore, the project demonstrates that

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integrating interactive, technology-based learning platforms into learner driver mentor programs can increase participation in road safety education and support more consistent delivery of key safety messages and attitudes.

The results also highlight the value of consultation and co-design in developing effective road safety education and interventions. Engaging program participants, practitioners and other road safety stakeholders in the design process can help ensure that education resources are relevant, practical and aligned with contemporary learning practices.

For policy and program development, these findings suggest that learner driver support initiatives should embed structured road safety education as a core component of programs, with an emphasis on co-design and collaboration for effectiveness. Such approaches have the potential to promote safer driving attitudes and behaviours, increase meaningful learning and engagement, and contribute to broader efforts to reduce road trauma.

Conclusions

The redevelopment of the Braking The Cycle road safety education platform demonstrates the value of translating research evidence and stakeholder consultation into practical road safety education initiatives. Through a consultation and co-design process involving program participants, staff, volunteers and other road safety stakeholders, the BTC program developed an interactive, technology-based learning platform designed to improve accessibility, engagement and learning retention among young learner drivers.

Early results indicate a substantial increase in engagement, with almost 750 hours of road safety education completed within the first three months of the platform's launch. The inclusion of shorter, interactive learning modules and opportunities for participant reflection supports deeper engagement with key road safety concepts, and reinforces the responsibility associated with learning to drive.

Future work will focus on ongoing monitoring of engagement and learning outcomes, as well as continued refinement of the platform based on participant and practitioner feedback. In addition, work has now begun on developing road safety education resources for diverse communities including our Changing Gears programs, which are based in remote First Nations communities throughout Queensland.

These findings highlight the potential for evidence-informed, collaboratively designed road safety education initiatives to strengthen learner driver programs and contribute to safer driving behaviours among young drivers.

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Development of novel bicycle helmet safety rating program

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Presenter: Gregory Dikranian

Abstract
A two-stage feasibility study was conducted to establish a bicycle helmet safety rating program called the Helmet STAR program (the Program). The study consisted of both the technical aspects of helmet testing and rating and overall feasibility of the Program, including investigation on socio-economic, operational considerations, benefit-to-cost ratio and the potential of the Program as an audit tool. The study found that the Program could provide important information to consumers related to helmet protective performance and price. The study demonstrated that there is no consistent relationship between helmet price and performance. It was also estimated that the Program has the potential of preventing 0.3 fatalities and 13 serious head injuries annually in NSW and can be used as an audit tool to ensure helmet compliance with the mandatory standard.

Background
Following the inquest into the death of a helmeted cyclist, the NSW Deputy State Coroner Court recommended that Transport for NSW conduct a feasibility study to investigate the need to establish a bicycle helmet rating program. In addition, it was recommended that the study included an audit of the conformity of bicycle helmets to Australian/New Zealand Standard 2063: *Helmets for use on bicycles and wheeled recreational devices* (AS/NZS 2063).

Conference theme
The theme for this paper is *From Evidence to Action: Shaping a Brighter Future* that is exploring the development and implementation of a consumer rating program to assist bicycle riders to select the safest helmet.

Method
A two-stage feasibility study was conducted. The first stage was a desktop study comprising an audit of bicycle helmets sold in Australia, a literature review on injury risks and helmet effectiveness in preventing head injuries and discussions with organisations involved in cycling and/or the supply of helmets. The second stage was divided into two parts. Part 1 involved the testing of eleven helmets to examine the test and scoring methods. Part 2 applied the test and scoring protocols from Part 1 to 50 helmets. Other aspects of the Program including socioeconomic, operational considerations, broader road safety and interjurisdictional implication were also investigated. The safety benefit of the Program was analysed by calculating the estimated reduction in casualties as a result from the Program.

Results
The first stage found that there are more than 500,000 helmets sold in Australian per annum. There is a large range of bicycle helmet models available. The helmets can be categorised into relevant types, e.g. road, skate/bike, general, child and mountain bike. Some helmet models are available for sale for at least 18 months, and many are available for more than five years.

A testing protocol was developed to assess the helmet performance against the following criteria:
- Helmet Retention: The dynamic strength of the helmet strap and the helmet's ability to remain securely on the head during movement are assessed to determine the helmet's stability. This performance was assessed using test requirements stipulated in AS/NZS 2512.7.2 for the dynamic stability and AS/NZS 2512.5.2 for the dynamic strap strength.
- Head Protection: The extent of head coverage and the helmet's capacity to attenuate impact energy are tested through drop tests from various heights (800 mm, 1500 mm, and 2000 mm) onto a flat anvil. Additionally, load distribution across the helmet is analysed for effective head protection.
- Angular Impact Management: While not included in AS/NZS 2063, angular impact management is critical for brain protection. This performance area is evaluated using the oblique impact test rig and method as those used in the Consumer Rating and Assessment of Safety Helmets (CRASH), except using drop heights and travelling speeds relevant for cyclists: the drop height is 1400 mm and the platform speed is 25 km/hr for adult helmets and 800 mm drop height and 15 km/hr platform speed for child helmets. This test is illustrated in Figure 1.
- Regulatory Compliance: The helmet's adherence to safety-critical requirements outlined in AS/NZS 2063 is also assessed to ensure it meets established safety standards.

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Figure 1. **Oblique impact test**

A total of 61 helmet models with a price range of $17 to $549 were tested in stage two using the testing protocol developed in stage one. A scoring protocol was then developed to discriminate between helmets on safety critical performance and to allow for comparisons between the best and worst performers.

The rating results for the 61 helmets demonstrated meaningful performance differences between helmet models that can be assessed in a laboratory-based star rating program, as shown in Figure 2. The results indicated that the test methods were repeatable and intra-helmet variation was low.

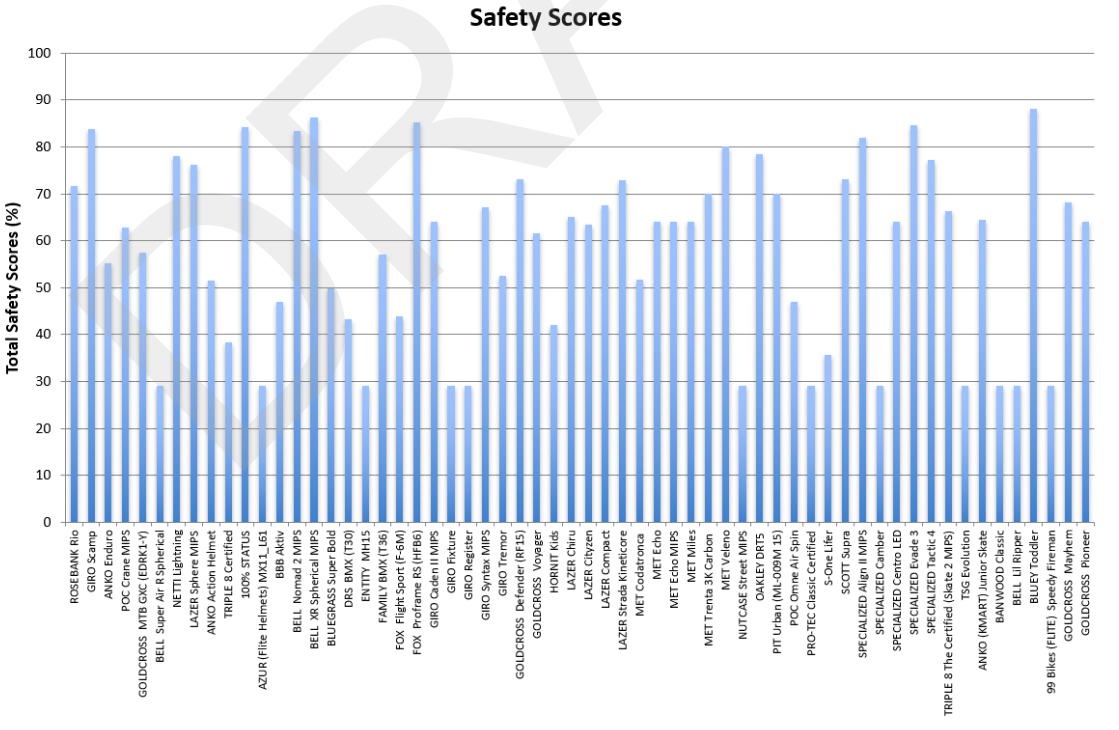

Figure 2. Scoring results of the 61 helmets

The study also examined the socio-economic implication of the Program; whether it would have the potential to dissuade helmet suppliers from providing low-cost helmets if they performed poorly, as well as unintentionally creating a barrier to socioeconomically disadvantaged riders accessing a helmet. The results show this is unlikely to be an unintended consequence because a weak relationship was observed between price and crash protection performance. In fact, it was found that several low-cost helmets scored 5-stars.

The safety benefit of the Program was investigated using bicycle casualty crash statistics in NSW and the NSW Health Linkage data for the period 2013 to 2022 (shown in Figure 3). Based on the proportion of riders who sustained a head injury despite wearing a helmet, it was estimated that annually, an average of 261 helmeted cyclists who sustained serious head injuries and 6 helmeted cyclists who were fatally injured due to head injuries may benefit from improved helmet performance.

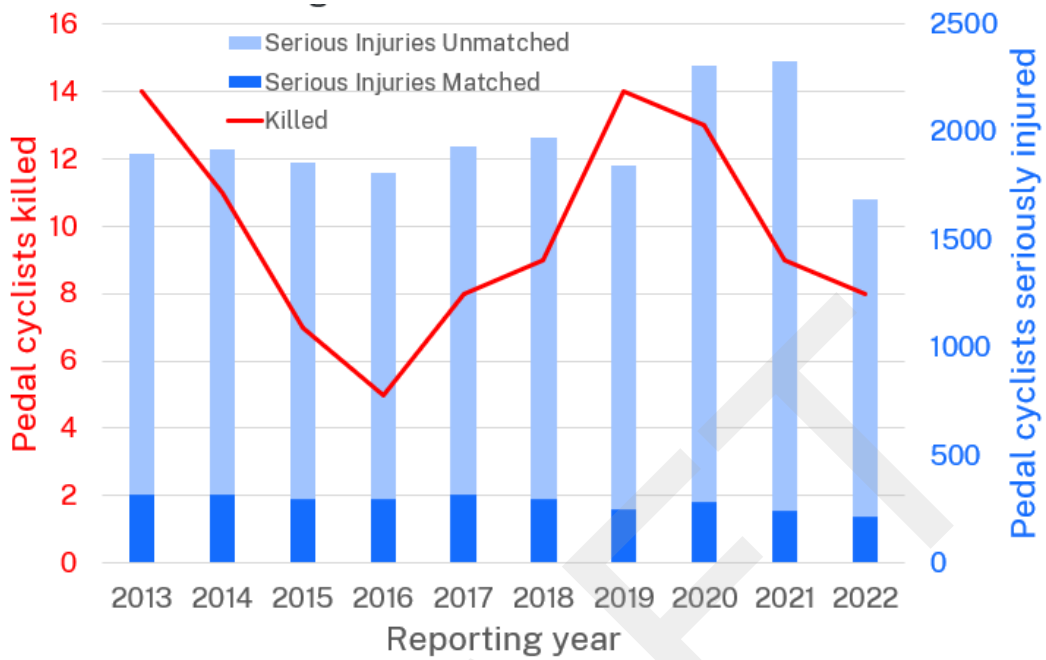

Figure 3. NSW Health Linkage Data 2013-2022

The study found that, with regards to the protection offered by the helmets as assessed in the 1500 mm and 2000 mm impact energy attenuation tests, the wearer of a 1-star helmet has two to two and a half times greater likelihood of serious to severe head and brain injuries compared to a cyclist wearing a 5-star rated helmet. It was assumed that if the program were to influence just 10% of those who could benefit from improved helmet performance to change from a 1-star helmet to a 5-star helmet and halve the risk of serious and severe head and brain injuries, then an estimated 0.3 fatality and 13 serious injuries could be saved per year in NSW. This life saving benefit can also be extended nationally by encouraging other jurisdictions to promote the Program.

The study also investigated the potential for the Program to be used to provide an important ongoing program of continuing local Australian audit of bicycle helmet safety performance and compliance with AS/NZS 2063. As part of the audit function, the two tests stipulated in AS/NZS 2063:2008 namely, retention strength and energy attenuation tests, were included in the testing protocol. It was observed that several helmet models failed testing that is mandated in AS/NZS 2063 and warranted investigation by the Australian Competition and Consumer Commission (ACCC) of their overall compliance with the standard. If helmets are found to be non-compliant with the mandatory Standard, the ACCC has the ability to require a recall of the helmet from the Australian market.

Conclusions

The results of the two-stage feasibility study demonstrate that establishing a bicycle helmet safety rating program is highly feasible. Such a program would provide consumers with valuable information regarding helmet protection performance and pricing. Significant performance differences between helmet models were identified, which can be effectively assessed through the program. The implementation of the program is expected to contribute to a reduction in fatalities and serious injuries by encouraging the use of higher rated, more protective helmets. In addition, the Program is a step forward in consumer empowerment and data-driven regulation in the cycling safety space.

Acknowledgement

The authors would like to acknowledge Mr Devaraj Muniswami and Mr Damien Mcallister from Crashlab for assisting in testing the helmets.

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Resolving he-said/she-said crashes: a case study

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Abstract
In a 90-degree intersection crash at a signalised crossroad involving two drivers with no CCTV and no independent witnesses, how can we know which driver made a mistake and ran a red light? We were asked to conduct a forensic engineering investigation into this late-night crash which resulted in one of the drivers being seriously injured. We identify the multidisciplinary factors that contributed to this crash occurring, aimed at informing road asset managers, traffic management operatives, and road safety policy makers on how the lived experience of drivers and road users is influenced by many layers of infrastructure, design, and circumstances. We will walk through the investigative process covering diverse disciplines such as vehicle damage assessments, kinematic analyses, driver perception and vehicle acceleration/braking/speed profiles, which are in addition to road management staples such as sight distance, traffic signal design, phasing and timing.

Introduction
On a 2021 winter's Friday night in the southeastern suburbs of Melbourne, two cars collided at a suburban signalised intersection at around 11pm. The usually busy arterial roads were quiet at this hour as the traffic signals ticked away, silently, ceaselessly cycling through their programming.

The signals are designed and built to be fundamentally as safe as possible, which means conflicting green lights are simply not possible – that sort of mistake was engineered out of SCATS (the software called "Sydney Coordinated Adaptive Traffic System" which controls all traffic lights in Melbourne) many decades ago.

Triple-0 is called and police attend, prioritising the well-being of both vehicle occupants. Ambulances arrive to treat the injured, but the apparent severity is not high, so the major collision unit is not called and no efforts are made to capture the scene evidence. After the injured are seen to, the focus is on making the scene safe, and then the clean up to re-open the road. Police canvass for CCTV footage but there is none to be found. With both drivers insisting they had a green light and no independent witnesses, police do not charge any driver.

Conference theme
There can be no stronger, richer evidence base than actual real-world crashes. The detail encompassed in each crash is an abundant vein of insight that should be tapped to shape road safety policy in ways that avoid the risk of adopting ideological, reductionist and ultimately ineffective approaches to reduce road trauma.
Tapping insight from real-world crashes has historically been difficult to achieve due to the complexities of each case. But, with growing technological capabilities like artificial intelligence, telemetry, dashcams and a population that is increasingly comfortable with tech while growing ever more connected, the potential for success in this endeavour grows with the passage of time.

Method
A crash reconstruction is unlike most road safety projects in that there is no opportunity to plan. One simply has to rely upon the evidence presented, which is usually incomplete and of varying quality. However, this does not mean that the quality of insight is necessarily poorer, as the reconstructionist can rely on the principle that all the evidence will point towards one truth.

Evidence
We started with a review of the available physical evidence: photos of the crashed vehicles in their rest positions, details of the injuries incurred, police BWC (Body Worn Camera) footage, and documented accounts from each of the drivers.

Infrastructure
We then took a detailed look at the intersection itself, including the lane layout on all legs. We made day and nighttime site visits to observe both infrastructure and typical traffic patterns, giving a good subjective feel for the conditions experienced on the night of the crash. We obtained daily traffic volume figures and noted parking restrictions and practices. We assessed sightlines to the signal lanterns and across the approaches taken by the cars

Signals
We then obtained the traffic signal controller "Op Sheet", which outlines the programming of its behaviour, checked its validity for the date of the crash and examined the signal phasing and timing. The pivot phase was identified, and in line

with observations during the nighttime site visit, we documented the likely signal timings experienced by the other phases, and the phasing sequence. Since the crux of the dispute was “who had the green light” and therefore “who disobeyed the traffic signal”, a considerable amount of time was spent considering the operation of the signals in detail.

Reconstruction
Having comprehensively examined the infrastructure, including the signal operation, we turned our attention to the documented aftermath of the crash, and worked backwards to reconstruct the crash.

Damage assessment, point of collision
The documented injuries and vehicle damage were consistent with a side impact crash at suburban speeds. The bullet vehicle showed clear front end damage, and the target vehicle was damaged along the driver’s side. Both vehicles had spun around 180 degrees from their original headings.

We drew upon driver behaviour knowledge and their statements to establish their intended paths through the intersection, which then identified the point of collision.

Momentum conservation kinematic model
From the point of collision to the vehicle rest positions, a 360-degree conservation of momentum kinematic model was built to describe each car’s movements, validated by their ultimate rest positions. The bullet vehicle’s brakes had locked on, simplifying the model while the target vehicle exhibited more complex staged movements in the model.

Human factors and driver behaviour
Human memory after participating in a motor vehicle crash is generally unreliable, particularly so when a threat of prosecution or guilt finding exists, as is commonly perceived after a crash where “someone must have done the wrong thing.” Erroneous recall is not necessarily a malicious act but could reflect a genuinely held (yet mistaken) belief around the circumstances, which supports the individual driver’s actions.

In this case where both drivers claim to have a green light applicable to their movements, it was worth testing their individual claims against the physical evidence and known circumstances of the road environment, in particular the traffic signal programming and likely signal timings experienced at the time of the crash.

Our investigation outlined the recollection of both crash participants, weighted them in accordance with forensic crash investigation practices, and allowed us to present an opinion on the most likely chain of events that gave rise to the crash.

Findings
Typical of crash investigations, the findings within this project are a multi-staged cascade, as subsequent directions in the investigation were predicated on the findings in a previous stage. The sequence that eventually resulted in this project were as follows:

1. Documented injuries and the vehicle damage assessment indicated how the vehicles connected and where they were positioned prior to colliding (Figure 1).
2. Police BWC footage allowed us to assume that of one of the vehicles brakes had locked on, allowing us to have more confidence in its post-collision movement characteristics and aiding the crash reconstruction.
3. When combined with the above, the final rest positions of each vehicle then allowed us to conduct the reconstruction, which then allows us to map out how both vehicles moved during the collision (Figure 2).
4. The reconstruction also allows us to estimate pre-collision speeds of each vehicle.
5. These speeds were then contextualised with each driver’s account of the crash.
6. The target vehicle driver’s statements were found to be largely consistent with the physical evidence. The low pre-collision speed was consistent with accelerating from rest on a fresh green light.
7. The bullet vehicle driver’s statements were found to be less consistent with the physical evidence. They claimed that they had a green light during their entire approach duration, but this conflicted with signal timing at that hour which would typically only have 8 seconds of green time.
8. We also identified a plausible misinterpretation of the traffic signals which could have been a factor in the bullet vehicle driver’s behaviour: left turn green arrows may have been mistaken for through movement green lights.

We concluded that the most likely cause of the crash was the bullet vehicle driver entering the intersection on a red light after mistakenly thinking the two green left turn arrows were a green light for their through movement.
Due to the presence of a building that is built right up to the property boundary on the southwestern corner of the intersection, there was no opportunity for either driver to perceive and react to avoid the impending collision. The resulting crash occurred just as the target vehicle accelerated away from the stop line in accordance with their fresh green signal. The kinematic analysis outlined the likely movements of both cars immediately prior to and following the

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collision, and the vehicle damage analysis supports the findings of the kinematic analysis in relation to vehicle speeds prior to the collision.

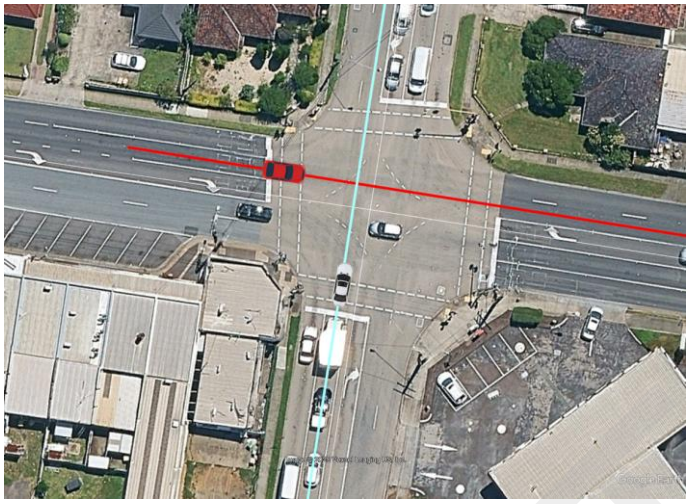

Figure 1. Pre collision vehicle paths
Source: Author markup of Google Earth aerial photograph

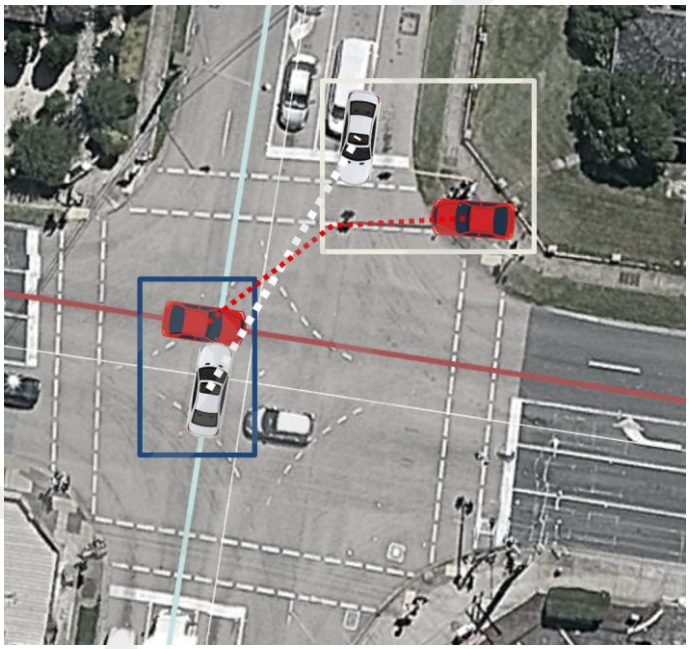

Figure 2. Collision diagram
Source: Author markup of Google Earth aerial photograph

Benefits to road safety and Implications for policy and/or practice

Mining individual crashes for data and insight to effectively contribute to road safety is no small undertaking. It is easy to dismiss each crash as unique, occurred under unrepeatable circumstances, and therefore not relevant to the broader picture.

This author disagrees. There can be no stronger, richer evidence base than actual real-world crashes. The detail encompassed in each crash is an abundant vein of insight that should be tapped to shape road safety policy in ways that avoid the risk of adopting ideological, reductionist and ultimately ineffective approaches to reduce road trauma. Just because it is difficult does not mean we should not try. As innovators, we aim towards the goal knowing that our first attempts will be poor, but then we iterate and improve, and over time, the benefits will become clear.

Conclusions

Using a multidisciplinary approach, and with enough detail in the evidence, it is possible to opine on he-said/she-said situations to a level of robustness that satisfies the judiciary. Of more relevance to road safety policy and practice, we as a community should advocate for and support the use of insight from real-world crashes as evidence, so that our actions will actually result in a brighter future.

Safety analysis of slip lanes at signalised crossings

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Abstract
Pedestrian safety at signalised intersections is a primary concern in urban road design. Slip lanes have recently been questioned due to concerns that they may increase pedestrian risk through higher vehicle speeds and increased driver cognitive load. This study evaluates whether slip lanes present a disproportionate pedestrian crash risk compared with standard left-turn movements. Pedestrian crash data from 2016–2023 across 34 Local Government Areas in Greater Sydney were analysed. Over 8,300 left-turn treatments and 282 pedestrian-related crashes were identified and categorised by turn configuration. Crash outcomes were compared with the prevalence of each treatment type within the network. Results indicate that slip lanes are under-represented in pedestrian injury crashes relative to their share of the network (representation factor = 0.71), while standard left turns are slightly over-represented (1.06). These findings suggest that slip lanes are not inherently more dangerous than standard left turns within the study network.

Background
Slip lanes are commonly used at signalised intersections to allow left-turning vehicles to bypass the main intersection and reduce delays. Typically implemented as channelised turning roadways separated from the main carriageway by a traffic island, slip lanes enable vehicles to complete left turns independently of the main signal phase. Previous studies have shown that slip lanes can improve intersection performance and reduce queue lengths and delays for turning movements (Sharobim, 2016). However, concerns have been raised that slip lanes may increase risk to pedestrians due to higher turning speeds, additional conflict points, and potential driver distraction (Jiang et al., 2020). At the same time, the safety implications of slip lanes are not universally negative. The channelised geometry can simplify turning movements and, in many cases, provide pedestrian refuge islands that reduce crossing distance and exposure time. Design guidance such as the *Austroads Guide to Road Design* therefore incorporates a range of safety treatments for slip lanes, including warning signage, controlled pedestrian crossings, reflectorised crossing bars, and geometric measures such as deceleration lanes and tapers intended to manage vehicle speeds and improve pedestrian visibility (Austroads, 2023). Recent policy discussions in Australia have nonetheless questioned the continued use of slip lanes in high-pedestrian environments. For example, guidance in Queensland discourages their installation in certain contexts, while other jurisdictions have strengthened design requirements for pedestrian crossings and warning treatments (Department of Transport and Main Roads, 2018; Austroads, 2023).

Despite these discussions, empirical evidence quantifying pedestrian safety outcomes at slip lanes remains limited, particularly in the Australian metropolitan context. This study therefore evaluates the relative safety of slip lanes compared with standard left-turn treatments at signalised intersections across metropolitan Sydney.

Conference theme
The theme “From Evidence to Action: Shaping a Brighter Future” highlights the importance of translating empirical research into practical road safety decisions. Slip lanes are a form of intersection infrastructure that has become increasingly contested in policy discussions due to perceived pedestrian safety risks. This study contributes to this debate by providing empirical evidence on pedestrian crash outcomes associated with slip lanes relative to other left-turn treatments. By quantifying safety performance using real-world crash data, the findings support more evidence-informed planning and design decisions consistent with Safe System and Vision Zero principles.

Method
To support the evidence-based evaluation outlined in the preceding sections, this study quantified the relative safety of pedestrians at signalised intersections when interacting with vehicles turning left. The analysis compared pedestrian crash outcomes associated with standard left turns and different types of slip lanes across metropolitan Sydney. Ideally, pedestrian safety would be evaluated using exposure-based crash rates incorporating pedestrian and traffic volumes. However, comprehensive city-wide exposure data were not available for this study. As an alternative, an approach like that used by O’Brien et al. (2012) was adopted, comparing pedestrian crash occurrence across different left-turn treatments and normalising results by the prevalence of each treatment within the road network.

Crash records from 2016–2023 were extracted from the NSW crash database, representing the most recent eight-year period available. The dataset was filtered to include pedestrian-related crashes occurring at signalised intersections within metropolitan Sydney. Relevant crashes were identified using Traffic Unit classifications of “Pedestrian” and

Road User Movement (RUM) codes of 0, 2, 3, 6, or 9. Roundabouts and T-intersections were excluded as they fall outside the scope of the analysis.

The methodological process comprised four main stages:

1. Identification of pedestrian-related crashes involving left-turning vehicles at signalised intersections.
2. Classification of left-turn movements by treatment type, including standard left turns and several slip lane configurations, as shown in Figure 1.
3. Identification and categorisation of all corresponding left-turn treatments across the study network.
4. Comparison of crash occurrence with the share of each treatment type in the network to estimate relative crash rates.

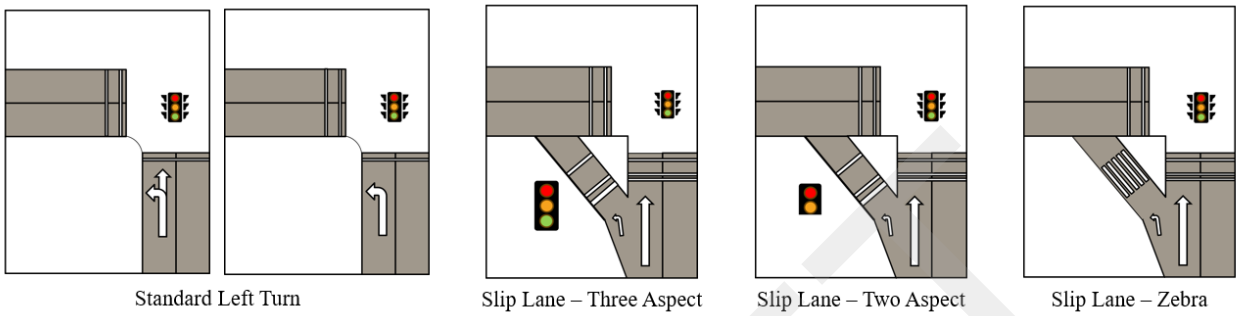

Figure 1: Left turn categorisation

Because slip lanes and standard left turns are not evenly distributed across the road network, raw crash counts alone would not provide a meaningful comparison. The analysis therefore compared each treatment's share of pedestrian injury crashes with its share of the network. This normalisation enabled an assessment of whether specific turn treatments were over- or under-represented in crash outcomes.

While this approach provides a useful comparative assessment, it assumes broadly similar exposure conditions across treatment types and may therefore be influenced by differences in pedestrian activity levels or traffic volumes across locations. Nevertheless, the method provides a practical means of examining relative safety performance at a metropolitan scale where detailed exposure data are unavailable.

Results

Crash rates for each left-turn configuration are summarised in Table 1. Standard left turns recorded the highest crash rates, with 36.0 total crashes and 39.2 fatality or injury crashes per 1,000 sites per year. In comparison, slip lane treatments generally exhibited lower crash rates. Slip lanes with three-aspect signals recorded 25.6 total crashes and 28.8 fatality or injury crashes per 1,000 sites per year, while zebra-controlled slip lanes recorded slightly higher rates. No crashes were observed at slip lanes controlled by two-aspect signals during the study period. Overall, when aggregated, slip lanes recorded lower crash rates than standard left turns.

Table 1. Crash rates and number of injuries by left-turn configuration (2016-2023)

Left Turn Type	Total Crashes per 1000 sites (per year)	Fatality/Injury per 1000 sites (per year)
Standard Left Turn	36.0 (4.5)	39.2 (4.9)
S.L. (Zebra)	33.5 (4.2)	33.5 (4.2)
S.L. (Three Aspect)	25.6 (3.2)	28.8 (3.6)
S.L. (Two Aspect)	0.0 (0.0)	0.0 (0.0)
S.L. (Total)	25.6 (3.2)	26.4 (3.3)
Total	34.3 (4.3)	37.1 (4.6)

(Note: S.L = Slip Lane)

Because different left-turn treatments are not evenly distributed across the network, crash outcomes were also examined relative to the prevalence of each treatment type (Table 2). Standard left turns represent most left-turn infrastructure, accounting for 83.9% of sites, while slip lanes collectively represent 16.1%.

To account for these differences in prevalence, a **representation factor** was calculated by dividing each treatment's share of injury crashes by its share of the network. A value greater than 1.0 indicates that a treatment is over-represented in injury crashes relative to its network presence, while a value less than 1.0 indicates under-representation.

The results indicate that standard left turns are slightly over-represented in pedestrian injury crashes relative to their presence in the network (representation factor = 1.06). In contrast, slip lanes collectively are under-represented (0.71),

indicating that they account for a smaller share of injury crashes than would be expected based on their prevalence in the road network.

Table 2. Network prevalence and injury crash representation by left-turn type

Left Turn Type	Share of Network (%)	Share of Injury Crashes (%)	Representation factor
Standard Left Turn	83.9	88.5	1.06
S.L. (Zebra)	9.5	8.5	0.90
S.L. (Three Aspect)	3.8	3.0	0.77
S.L. (Two Aspect)	2.9	0.0	N/A
S.L. (total)	16.1	11.5	0.71

(Note: S.L = Slip Lane)

Implications for road safety and practice

The findings provide empirical evidence to inform ongoing debates regarding the safety of slip lanes in urban environments. After accounting for their prevalence within the road network, slip lanes were not over-represented in pedestrian injury crashes when compared with standard left turns, with signalised slip lanes demonstrating the lowest relative crash occurrence.

These results suggest that slip lanes should not be universally treated as a higher-risk intersection treatment. Instead, their safety performance appears to depend on design and control characteristics, particularly the management of vehicle speeds and pedestrian crossings. For practitioners, the findings support a more evidence-informed approach to intersection design, where decisions regarding slip lane provision consider both operational efficiency and pedestrian safety outcomes. Further incorporation of empirical crash data into intersection design guidance and risk assessment frameworks may assist planners and engineers in selecting appropriate turning treatments for different urban contexts.

Conclusions

This study evaluated pedestrian safety outcomes associated with different left-turn treatments at signalised intersections across metropolitan Sydney. When normalised by network prevalence, slip lanes were under-represented in pedestrian injury crashes relative to standard left turns, indicating that they do not inherently pose a greater safety risk. Signalised slip lanes demonstrated the strongest safety performance among the configurations examined. However, the results also highlight the importance of intersection design measures that manage vehicle speeds and support driver awareness of pedestrians. While the analysis was limited by the absence of exposure data, the findings contribute empirical evidence to support more balanced and evidence-based decision making regarding slip lane use in urban road networks.

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Crashes that current Safe System approaches do not address

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Abstract

Characteristics of crashes that safe system approaches have limited countermeasures to address were examined. A sample of 477 in-depth investigations of casualty crashes in South Australia between 2014 and 2024 were reviewed and intervention strategies to prevent the crashes and mitigate injury severity were nominated, along with a confidence level that the intervention would be effective (high/medium/low). Sixty-eight crashes had no interventions with a high confidence level and two or less with a medium confidence level. These study crashes were compared to 409 crashes with at least one high confidence intervention and/or more than two medium confidence interventions. Study crashes were statistically significantly more likely than comparison crashes to be pedestrian (8.8 vs 4.2%), side swipe (14.7 vs 4.2%) and single vehicle crashes (44.2 vs 29.6%), and occur midblock (64.7 vs 49.9%), involve incorrect positioning (10.3 vs 3.2%), involve suicide (4.4 vs 0.2%) and involve a motorcycle (26.5 vs 10.0%).

Introduction

The safe system concept suggests that humans make errors that lead to crashes, but road users should not be seriously or fatally injured as a result (Fosdick et al., 2024; Woolley et al., 2018). A safe system is built around road users to accommodate for human error through infrastructure, vehicular and human-based countermeasures to prevent crashes occurring or mitigate injury outcomes. The most common factors that contribute to crashes are related to humans (in around 90 to 100% of crashes), but the interventions that can effectively prevent or mitigate the crashes are most commonly infrastructure treatments or vehicle technologies (Cuerden & McCarthy, 2016, Doecke et al., 2020; Jänsch et al., 2012). Many crashes can be addressed through a safe system approach, however, for optimal future effectiveness of the concept, those crashes that safe system approaches currently have limited scope to address must be identified. The present study examines crashes that have few countermeasures that could successfully prevent or mitigate them.

Conference theme – From evidence to action: Shaping a brighter future

The safe system concept must have means to prevent or mitigate all types of road crashes to be a viable solution to road trauma and achieve **future** targets for reductions in deaths and serious injuries. This study identifies the crash types that current safe system approaches have limited scope to address. As such, this study provides **evidence** of the gaps in safe system thinking and highlights where **action** needs to be taken to provide gains in **future** road safety efforts.

Method

In-depth at-the-scene investigations of casualty crashes by CASR in South Australia (SA) from 2014 to 2024 were analysed. Investigations begin with notification from the SA ambulance service that an ambulance has been sent to a crash. Investigators attend if it occurs within 100 km of Adelaide. This limits travel time so that evidence is preserved upon arrival. Other criteria are that at least one participant must be transported by ambulance, the crash occurred on a public road, and it involved at least one motor vehicle. The team is on call to attend crashes between 9am and 9pm, Monday to Friday, with weekend shifts also recently included. Fatal and life-threatening crashes occurring outside of these hours, which are attended by SA Police's Major Crash Investigation Squad, are investigated in the following days. At a crash scene, investigators talk to emergency service personnel, participants and witnesses; mark evidence; photograph the scene, vehicles and road infrastructure; collect data on the vehicles, road and crash circumstances; digitally map the road environment and crash evidence; and record videos from each road user's direction of travel. Further information is obtained after the crash, including the police report, hospital and ambulance notes, participant and witness interviews, Coroner report (if fatal), forensic report (alcohol and drug test results), and crash history of the location and road users involved. Injuries are coded using the Abbreviated Injury Scale. Speeds of vehicles are determined, if possible, by crash reconstruction that utilises scene evidence. Crashes are reviewed by experts in human, road and vehicle factors to determine which factors contributed to the crash occurring. Contributing factors are selected based on all collected evidence. Multiple contributing factors can be selected for each crash. Interventions that could have prevented the crash or mitigated its severity (e.g., roundabout) are nominated along with a confidence level (high, medium or low) based on the expert's knowledge of the intervention being effective under the specific circumstances of the crash. Interventions must be reasonable in potential cost and practicality to be considered. Automated and connected vehicles are not considered as their operation in specific crash situations is still unknown. Interventions are grouped according to whether they are human, vehicle or road based. Multiple interventions can be selected for each crash.

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A crash was included in the current examination if all data collection and matching had been completed and it had been reviewed. This resulted in 477 crashes. Crashes were identified as having limited current countermeasures if the review could not nominate an intervention to prevent or mitigate the crash with a high associated confidence level or more than two interventions at a medium confidence level. Low confidence interventions were not considered in this process. Sixty-eight (14.3% of 477) such crashes were identified (hereafter referred to as study crashes). Crashes with a high confidence intervention and/or more than two medium confidence interventions were used as a comparison sample, with a total of 409 (85.7% of 477, hereafter referred to as comparison crashes). Frequency counts and chi-square tests (alpha level of 0.05 for statistical significance) were used for analyses through SPSS and Microsoft Excel.

Results

Table 1 shows the types of crashes investigated. Differences between study and comparison crashes were statistically significant ($\chi^2(8) = 35.2$, $p < .001$). Study crashes were more likely to be pedestrian, side swipe and single vehicle crashes (into, and not into, an object). Comparison crashes were more likely to be right angle and right turn in front. Table 2 presents the section of the road where the crashes occurred. More than 25% of the cells contained a frequency of less than 5 and, therefore, it was not possible to conduct an overall chi-square test. Instead, the groups were compared in terms of whether the crashes occurred at intersections or mid-block. Twenty-four (35.3%) study crashes occurred at intersections and 44 (64.7%) occurred mid-block, while 205 (50.1%) comparison crashes occurred at intersections and 204 (49.9%) occurred mid-block. The difference was statistically significant ($\chi^2(1) = 5.1$, $p = .023$), study crashes were more likely than comparison crashes to occur mid-block and less likely at intersections. Table 3 displays the types of road users involved. Chi-square tests were undertaken for different types of road users separately (i.e., whether a crash involved at least one of each type or not). Study crashes were statistically significantly more likely to involve motorcycles and scooters and less likely to involve passenger vehicles.

Table 1. Crash type

Crash type	Study number (%)	Comparison number (%)
Head on	4 (5.9)	25 (6.1)
Pedestrian	6 (8.8)	17 (4.2)
Rear end	9 (13.2)	63 (15.4)
Right angle	4 (5.9)	93 (22.7)
Right turn in front	0 (0.0)	51 (12.5)
Side swipe	10 (14.7)	17 (4.2)
Single vehicle into object	22 (32.4)	90 (22.0)
Single vehicle not into object	8 (11.8)	31 (7.6)
Other	5 (7.4)	22 (5.4)
Total	68 (100.0)	409 (100.0)

Table 2. Section of the road where the crash occurred

Road location	Study number (%)	Comparison number (%)
Cross road	2 (2.9)	86 (21.0)
Driveway	8 (11.8)	12 (2.9)
Merging lane	1 (1.5)	2 (0.5)
Mid-block	44 (64.7)	204 (49.9)
Pedestrian crossing	0 (0.0)	2 (0.5)
Roundabout	1 (1.5)	6 (1.5)
T-junction	12 (17.6)	97 (23.7)
Total	68 (100.0)	409 (100.0)

Table 3. Involvement of various road user types in crashes

Road user type	Study number (% of 68)	Comparison number (% of 409)	Chi-square test (* $p < .05$)
Passenger vehicle	50 (73.5)	366 (89.5)	$\chi^2(1) = 13.3$, $p < .001$*
Heavy vehicle	12 (17.6)	92 (22.5)	$\chi^2(1) = 0.8$, $p = .370$
Motorcycle/scooter	18 (26.5)	41 (10.0)	$\chi^2(1) = 14.5$, $p < .001$*
Pedestrian	5 (7.4)	15 (3.7)	$\chi^2(1) = 2.0$, $p = .160$
Bicycle	5 (7.4)	16 (3.9)	$\chi^2(1) = 1.6$, $p = .200$

Note: a crash can involve multiple road users, therefore, the sum of road users is larger than the total sample

There were many human, road and vehicle contributing factors examined between the groups (whether a specific factor contributed to a crash or not). Those that statistically significantly differed between the groups are shown in Table 4. Study crashes were more likely to involve incorrect positioning of a vehicle on the road (e.g., using parking lane to

overtake on the left) and suicide and less likely to involve exceeding the speed limit, failing to give way to another road user for an unknown reason, a confusing or complex road layout, and visibility issues of the road at the crash location.

Benefits to road safety

This study highlights that current road safety efforts have limited options to prevent or mitigate pedestrian, side swipe and single vehicle crashes, as well as those that occur midblock, involve incorrect positioning, involve suicide and involve a motorcycle. New and innovative road safety countermeasures and thinking are required to determine how these crashes fit within a safe road system to achieve targets for reductions in deaths and serious injuries.

Table 4. Factors that contributed to crashes

Contributing factors	Study number (% of 68)	Comparison number (% of 409)	Chi-square test (* $p < .05$)
Human: exceed speed limit	2 (2.9)	47 (11.5)	$\chi^2(1) = 4.6, p = .031$*
Human: fail to give way unspecified	2 (2.9)	57 (13.9)	$\chi^2(1) = 6.5, p = .011$*
Human: incorrect positioning	7 (10.3)	13 (3.2)	$\chi^2(1) = 7.3, p = .007$*
Human: suicide	3 (4.4)	1 (0.2)	$\chi^2(1) = 12.2, p < .001$*
Road: road layout	0 (0.0)	33 (8.1)	$\chi^2(1) = 5.9, p = .015$*
Road: visibility	2 (2.9)	59 (14.4)	$\chi^2(1) = 6.9, p = .009$*

Note: a crash can involve multiple contributing factors, therefore, the sum of factors is larger than the total sample

Implications for policy and/or practice

The knowledge provided here can direct future efforts by road safety researchers, advocates, and stakeholders towards gaps in safe system thinking and planning. The identified crashes pose challenges for road safety policy and practice. Pedestrians may cross the path of vehicles anywhere on the road system. Traffic lights and crossings can help but pedestrians may not use them, and vehicles may not stop or slow. Pedestrians and motorcyclists are vulnerable to injury despite protective riding gear for motorcyclists. Common passenger vehicle crash prevention technologies (e.g., lane keep assist, electronic stability control, autonomous emergency braking) are not common for, or incompatible with, motorcycles. Infrastructure countermeasures to improve safety for passenger vehicles, such as guardrails, may be counterproductive to motorcycle safety. Side swipe crashes are difficult to prevent on multiple lane carriageways, although blind spot monitoring and lane departure technologies can be useful. Guardrails reduce the severity of single vehicle midblock crashes but do not prevent them (i.e., still crash into the guardrail). Crashes involving suicide and incorrect vehicle positioning are difficult to prevent due to an unpredictable nature.

The comparison crashes are those for which road authorities have a range of interventions to address but are not uniformly implemented, often due to cost or practicality. More can be done to address these crashes, but it is not occurring consistently. Interventions exist to effectively prevent or mitigate intersection crashes (e.g., right angle, right turn in front and failure to give way), crashes in which the speed limit is exceeded, and crashes on roads with complex layouts or visibility issues, but this study found they had not been utilised. Many intersections are uncontrolled or have passive controls (give way or stop sign) but can be improved through signalisation, advanced warning signs, speed management, protected right turns and roundabouts (Doecke, et al., 2020). Road layout and visibility issues can be addressed through careful planning, design, redesign and maintenance. Advanced vehicle technology (e.g., intelligent speed assist) and enforcement can reduce speeding. Interestingly, crashes involving passenger vehicles were more commonly found to have additional interventions that could have assisted. This is likely related to advanced safety technology being available in newer vehicles but safety features can take more than a decade to permeate the vehicle fleet in Australia (Anderson et al., 2011).

Conclusions

There are currently limited countermeasures to improve the safety of certain crashes, which have been identified in this study. Also, while some crashes have limited effective interventions, others have many that are not being adequately utilised. Both require focussed consideration in future road efforts to build a fully realised safe road system.

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Speeding in ACT school zones: risks, findings and recommendations

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Abstract
Children are among the most vulnerable road users, and school zones play a critical role in reducing vehicle speeds to protect them. This study analysed speed distributions and compliance with the 40 km/h school zone limit across 59 schools in the Australian Capital Territory (ACT), using over 2.2 million vehicle observations collected between 2015 and 2023. While school zones significantly reduced mean vehicle speeds during active periods, 36% of vehicles still exceeded the limit, rising to 45% on roads with a 60 km/h default speed limit (applies outside of school zone times). Traffic-calming infrastructure and narrower lane widths were associated with meaningfully lower speeding rates. A comparison of school zone practices across Australian jurisdictions revealed substantial inconsistencies. The study recommends lower speed limits (ideally ≤ 30 km/h), extended active zone hours, broader adoption of traffic-calming measures, and expanded use of automated enforcement to better protect child pedestrians near schools.

Introduction
Child pedestrians are among the most vulnerable road users due to limited road experience, smaller physical size, still-developing cognitive and perceptual abilities, and unpredictable behaviour in traffic environments. International data consistently show that children experience higher rates of injury and fatality as pedestrians than as vehicle occupants (WHO, 2015). International studies confirm that pedestrian injuries are a leading contributor to serious childhood trauma and death (Beck et al., 2019; Borse et al., 2009). Children's vulnerability is compounded in contexts requiring accurate judgement of vehicle speeds and traffic gaps, skills that develop progressively through adolescence. Given that children may be near schools at times beyond standard arrival and departure peaks, it is essential that motorists travel at speeds that allow them to respond to unexpected situations. Reduced speed limits and visible school zone signage play a central role in improving safety.

In the Australian Capital Territory (ACT), a 40 km/h school zone limit applies between 8am and 4pm on school days. Although school zones reduce vehicle speeds, research shows motorists frequently exceed posted limits (Ellison et al., 2011, 2013). Critically, pedestrian injury severity increases substantially when collisions occur above 30 km/h (Hirsch et al., 2021), and serious injuries still occur with concerning frequency in 40 km/h zones (He et al., 2024). This study addresses a gap in existing research by investigating speed distributions and compliance in ACT school zones and by examining best practices across Australian jurisdictions.

Conference theme
This study translates evidence into action. By analysing speed compliance across 59 ACT school zones and benchmarking practices across all Australian jurisdictions, it delivers concrete recommendations on speed limits, active hours, infrastructure and enforcement to shape safer road environments for children.

Method
Vehicle speed data were provided by the ACT Government from speed surveys conducted between 2015 and 2023 using pneumatic tube counters at school zone sites across multiple schools. The surveys captured speed, direction, vehicle classification, and timestamp for each passing vehicle over at least one full week per site during school terms. From an initial dataset of 110 surveys, 17 were excluded due to GPS-confirmed locations falling outside designated school zones, and four pairs of bi-directional surveys were merged, yielding 89 surveys across 59 unique schools. Schools were categorised as Primary, Secondary, or K-12. Vehicle types were classified as light (sedans, 4WDs, utilities, vans) or heavy (trucks and buses).

Site characteristics, including default road speed limit (applies outside of school zone times), presence of traffic-calming infrastructure (speed humps, pedestrian crossings), and perceived lane width (researcher perception based) were categorised using Google Maps and Google Street View at the closest available pre-survey date. Vehicle speed records were grouped into three time categories: school zone times (weekdays 8am-4pm, 40 km/h limit), weekday non-school-zone times (before 8am and after 4pm), and weekend times. Statistical comparisons used Student's t-test, Welch's t-test, and one-way ANOVA with Tukey's HSD post-hoc tests ($\alpha = 0.05$).

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Results

The dataset comprised over 2.2 million vehicle observations. The weighted mean vehicle speed was lowest during school zone times (37.3 km/h) compared to weekday non-school-zone times (46.0 km/h) and weekends (46.6 km/h), differences that were statistically significant ($F(2,264) = 75.4$, $p < .001$, $\eta^2 = 0.363$). Despite these lower mean speeds, the proportion of vehicles exceeding the 40 km/h limit was highest during school zone times (36.4%), compared to 19.9% on weekday evenings and mornings, and 21.9% on weekends ($F(2,264) = 22.6$, $p < .001$). Further key findings included:

- School type (Primary, Secondary, K-12) showed no significant differences in speeding proportions ($F(2,86) = 0.03$, $p = .97$).
- School zones on roads with a 60 km/h default limit had higher mean speeds (39.6 km/h vs 35.8 km/h) and speeding rates (44.5% vs 31.2%) compared to 50 km/h default zones (both $p < .001$), as shown in Figure 1.
- Light vehicles were more likely to exceed the limit than heavy vehicles (36.8% vs 31.7%, $p = .048$), despite similar mean speeds.
- Sites with traffic-calming measures (speed humps, pedestrian crossings) had significantly lower speeding rates (29.8% vs 40.3%, $p = .004$).
- Perceived narrow lane width was associated with reduced speeding (29.7% vs 42.6%, $p < .001$).
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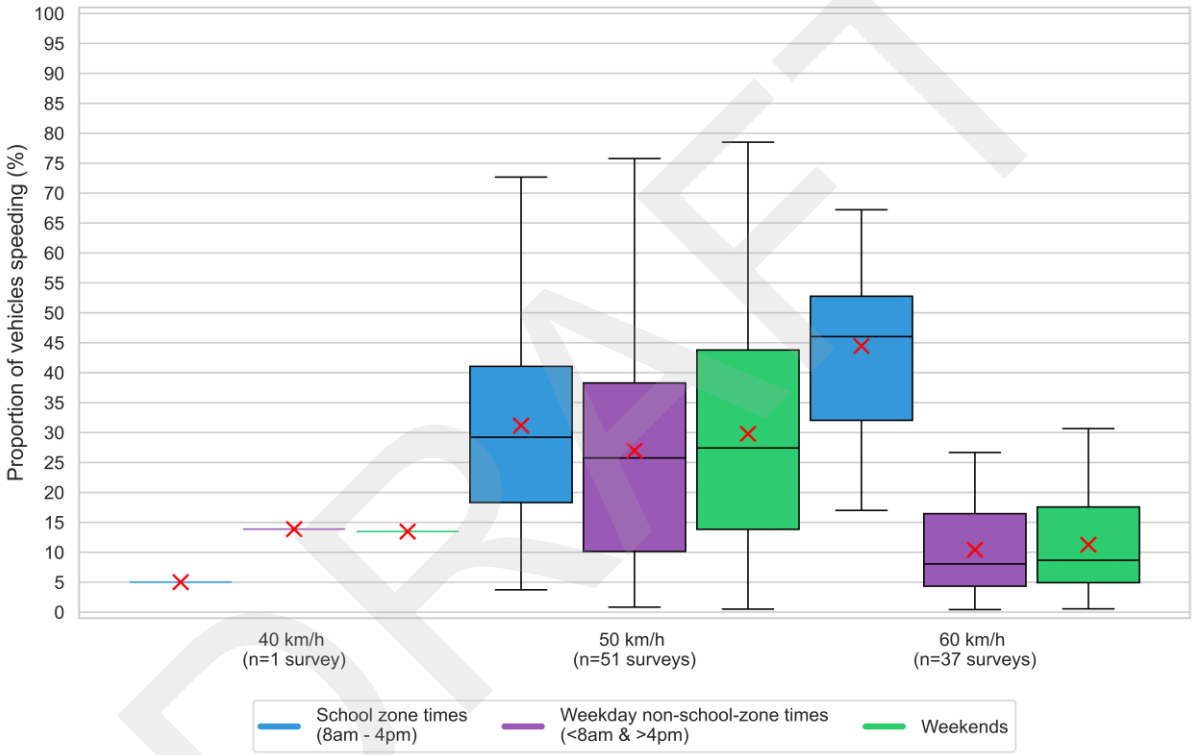

Figure 1. Box and whisker plots showing proportions of vehicles speeding for 40, 50 and 60 km/h zones, by school zone time category. Note that during school zone times (blue), speed limits at all sites were 40 km/h. Note also that the default 40 km/h zone had a sample size of one survey.

A comparison of school zone practices across Australian jurisdictions in Table 1 shows variation, which limits nationally consistent best practice.

Table 1. School zone regulations across Australian jurisdictions.

Jurisdiction	Speed limit	Active times
ACT	40 km/h	8am to 4pm
Northern Territory	40 km/h	7am to 5pm
Western Australia	40 km/h	Varies: northern region 7:30am to 9am and 2pm to 3:30pm, Carnarvon area 7:30am to 9 am and 2pm to 4 pm, all other areas (including Perth metro) 7:30am to 9am and 2:30pm to 4 pm
South Australia	25 km/h	Whenever children (under 18 years) are present
Queensland	40 km/h	Most zones 7am to 9am and 2pm to 4pm, some 7am to 4pm
Tasmania	40 km/h	8am to 9:30am and 2:30pm to 4pm
New South Wales	40 km/h	8am to 9:30am and 2:30pm to 4pm
Victoria	40 km/h	8am to 9:30am and 2:30pm to 4pm

Note: school zones for all states and territories except South Australia are active Monday to Friday only.

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Benefits to road safety

These findings demonstrate that school zones reduce vehicle speeds; however, the persistence of high non-compliance rates, particularly on roads with a default speed limit of 60 km/h, represented a significant ongoing risk to child pedestrians. At 40 km/h and above, the risk of fatal and serious injury to *adult* pedestrians remains unacceptably high relative to Safe System principles (Hirsch et al., 2021), let alone *child* pedestrians, who are even more vulnerable. The study showed that physical road design can substantially enhance the effect of speed limits alone. Traffic-calming infrastructure and narrower lanes were associated with meaningful reductions in speeding, suggesting that combining regulatory and engineering approaches offers greater safety gains.

Implications for policy and/or practice

Several policy and practice recommendations emerge from the evidence presented in this study:

- **Speed limits**: Current 40 km/h limits do not align with Safe System principles. The authors recommend that jurisdictions adopt school zone limits of no more than 30 km/h, and encourage limits of 25 km/h or lower where feasible. Each 1 km/h reduction in school zone speed limits has been estimated to reduce fatal and serious injury collisions by 4% (Sun et al., 2018).
- **Active hours**: The ACT's current 8am-4pm window reflects broader child activity patterns better than shorter split-window approaches used in other jurisdictions. However, adopting the Northern Territory model (7am-5pm) would provide more comprehensive protection given before/after-school programs, excursions, and other activities.
- **Signage and technology**: Electronic variable speed signs (as used in Tasmania), flashing beacons, and speed-monitoring displays have demonstrated speed reduction effects (e.g., Lee et al., 2006) and should be more widely implemented. Automated speed enforcement has shown positive outcomes in some settings (Freedman et al., 2006) and can complement physical design and signage interventions.
- **Infrastructure**: Broader adoption of traffic-calming features (speed humps, pedestrian crossings, narrowed lanes) should be prioritised, particularly in school zones situated on or adjacent to high-speed or high-volume roads. New school planning should favour locations away from major arterial roads; existing high-risk sites should be retrofitted with protective infrastructure, including physical separation of pedestrians and vehicles where feasible.

Conclusions

School zones in the ACT reduce vehicle speeds, but do not reliably achieve the operating conditions required to protect child pedestrians under Safe System principles. With more than one-third of motorists exceeding the 40 km/h limit during active school zone times, rising to nearly half on roads with 60 km/h default speed limits, the current settings leave children exposed to unacceptable injury risk. Changes to speed limits (ideally ≤ 30 km/h), active zone hours (extended to reflect real child activity patterns), physical infrastructure (traffic calming, lane narrowing, physical separation), and enforcement (automated and technology-aided) are all needed to meaningfully improve safety. These reforms align with Safe System principles and offer a feasible, evidence-based pathway to substantially reducing serious injuries and fatalities among child pedestrians near schools, with relevance for jurisdictions across Australia and internationally.

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Folk law and road governance

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Abstract
This paper shows that road governance involves formal rules and regulations, road infrastructure, and the novel concept of 'folk law'. This paper extends analysis undertaken in a series of projects on road governance over the past 10 years, including fieldwork in Australia, the United States, Canada and, most recently, France. These projects examined the role of law in advancing road safety, particularly for cyclists and other vulnerable road users. This paper synthesises and extends that analysis to develop the concept of 'folk law': understandings about the appropriate use of roads which derive their authority not from courts or legislatures, but from custom and social acceptance. Focusing on French responses to folk law around traffic lights, including reform to the national road rules, the analysis shows how folk law can be used to improve legal texts, infrastructure and enforcement practices, and in turn to reduce deaths and serious injuries among cyclists and other vulnerable road users.

Background
Law has a vital role to play in achieving the 2030 targets for deaths and serious injuries, and must be part of the collaborations necessary to develop solutions for a brighter future. The road environment is shaped and sustained by a vast array of rules and regulations. Among many others, these include: speed limits, parking requirements, engineering standards for high speed travel, zoning rules separating and extending the distances between land uses, financing arrangements facilitating toll roads, tax incentives for commuting and 'green' vehicles. To reduce deaths and serious injuries, these legal frameworks need reform.

While law is crucial, it is important to recognise that law is also constrained. In Australia and internationally, many cities are reforming laws to reduce reliance on private cars. Among other changes, municipalities are replacing parking minimums with caps and even outright prohibitions on the provision of car-parking; road rules are being revised to require drivers to maintain safe distances when passing cyclists; zoning codes are being rewritten to require decision-makers to prioritise development that supports public and active transport; new regulations are enabling businesses to create 'parklets' in spaces previously allocated for car parking; committees known for blocking cycling and pedestrian infrastructure are being abolished; and key legislation is being rewritten with a reform objective of "more contemporary uses for roads and streets that are safe and responsive to community needs" (Transport for NSW, 2025, p. 10). Yet progress on reducing deaths and serious injuries is too slow.

To change how roads are governed, legal change is necessary but not sufficient. Law can make something illegal or obligatory, but this does not guarantee that behaviour will change. Often, questions about legality in roads are resolved without going to courts or even engaging with lawyers. Public servants, planners and engineers can be crucial in determining what is and is not considered legal on the road.

To understand how legality functions in the road, it is important to examine not just formal rules and regulations but also their social and material context. Infrastructure is a key part of that context: we know that people are more likely to speed when driving on wider roads with more traffic lanes and less buildings around them (Ewing & Dumbaugh, 2009), and that 'intuitive' infrastructure can improve compliance and safety (Friel, 2023). Infrastructures reflect the legal framework; they are typically designed to comply with rules and regulations. Infrastructures can also shape those rules and regulations: new infrastructural technologies can give rise to new regulations and governance techniques. The pedestrian crossing, for example, is intimately connected with the prohibition on jaywalking (Norton, 2007). Speed cameras and breathalysers have had significant impacts on the enforcement of traffic rules. New technologies associated with electrification and 'smartification' are prompting further shifts.

Road governance depends on both formal legal rules and the physical infrastructure in which those rules take effect. This submission examines a crucial third element, defined as folk law.

Conference theme
This paper is future-focused in its engagement with the conference theme. It highlights 'folk law' as an underappreciated challenge threatening road safety, and describes ways to combat this threat. We must think about road governance differently, examining folk law to inform decisions about law reform, enforcement and infrastructure.

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Project description

This paper extends analysis of more than 150 interviews undertaken in a series of projects over the past 10 years. This includes interviews with people involved in: activism around car parking and the provision of safe infrastructure for pedestrians and cyclists in several cities across Australia, Canada and the US (2015-2023); electric vehicle charging in New South Wales (2021-2023); commercial cycling in Sydney and Melbourne (2021-2025); and changes in road governance in Paris, France (2025-2026). References have been omitted to maintain anonymity for peer review, but it is important to note that the work on EV charging and on commercial cycling were undertaken as part of larger teams beyond this paper. Interviews were transcribed and coded using nVivo, using grounded theory to derive the concept of folk law.

Findings

Folk law describes informal, everyday understandings about the appropriate uses and users of road space. 'Folk' emphasises the socially constituted nature of those understandings. Folk law describes ideas that are shared with a group, often through stories. 'Law' emphasises' that these are stories with power. Folk law describes understandings about what should be done.

Folk law is part of what is understood in socio legal studies as legality: the meanings, sources of authority and cultural practices that are recognised as legal, regardless of who employs them or for what ends (Thorpe, 2020). Folk law is related also to legal consciousness: the background assumptions about legality that structure and inform everyday thoughts and actions (Halliday & Morgan, 2013, p. 2). Folk law is different from, but connected to, concepts of 'folk crime' (Ross, 1973) and 'folk legality' (Marusek, 2016). The term folk law invokes also the concept of folklore used in anthropology and cultural studies to emphasise the importance of shared stories and social practices.

Folk law is an umbrella term, with at least three sub-types: 1) folk law which people think is law, a gap-filling form of legality; 2) folk law which people know is not law but feel is near enough, a casual form of violation often invoking privilege; and 3) folk law which people know is not law but think should be law, a form of prefigurative legality in which a desired future is enacted. These sub-types have different implications for road governance and for road safety.

The relevance of folk law to road safety practice is shown through an analysis of folk law related to red lights, informed by the literature demonstrating the prevalence of red light running among both motorists and cyclists (Johnson et al., 2013; Ross, 1973). In France, reflection on the folk law associated with red lights prompted reform to the national Code de la Route. In 2012, the Code de la Route was amended to include provision for M12 signs, which when present allow cyclists to continue through a red light in the direction shown on the sign (left, in the example shown in Figure 1). Through this change, the Code de la Route formalized folk law, turning what was a common transgression into a legal act, and in doing so improving road safety.

Figure 1. M12 sign, Paris
Source: Author

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Benefits to road safety

Understanding folk law can help to inform decisions on law reform, enforcement practices and infrastructure. Folk law can provide insights that can facilitate more effective implementation of new laws (such as minimum passing distances and speed limits), it can also inform changes which can reduce tensions between road users (such as M12 signs). Both can help to reduce deaths and serious injuries.

Implications for policy and/or practice

By informing better decisions on law reform, enforcement and infrastructure, the analysis of folk law in this paper can improve policy and practice to reduce deaths and serious injuries on our roads.

Conclusions

Law is widely recognised as crucial in road safety, yet understanding of how best to use law to advance road safety is limited. This paper offers a framework to understand the relationships between law, infrastructure and the practices of road users. With recent examples of successful law reform to improve road safety in France, it provides important insights to inform road safety practice in Australia.

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Is diabetes technology keeping pace with road rules?

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Abstract
Driving is essential for independence and daily living, yet for drivers with diabetes using glucose-lowering medication, hypoglycemia can impair cognitive function and compromise safety. Continuous glucose monitoring (CGM) can provide real-time alerts to help prevent hypoglycemia, but its role while driving remains unclear and evidence from real-world driving is limited. Updated Australian Road Rules (2023) now permit use of mounted or inbuilt devices to monitor a driver's condition, a provision that could facilitate safe in-car CGM use. Yet little is known about how well current CGM devices accommodate the driving context, and this regulatory framework provides clear rationale to explore this. This extended abstract presents findings from a national survey of 1,209 Australian drivers with diabetes on glucose-lowering medication examining associations between CGM use and hypoglycemia while driving, soliciting driver feedback on barriers to safe in-car CGM use, and exploring perceptions of what is currently legal regarding glucose monitoring while driving.

Introduction
Driving is an important activity for independence and daily living, requiring sustained attention and coordination (Cox et al., 2024). For drivers with diabetes using glucose-lowering medication, hypoglycemia can impair these abilities and compromise safety (Verhulst et al., 2022). Although crash risk among drivers with diabetes overall is similar to the general population, those with insulin-treated diabetes or impaired hypoglycemia awareness face higher risk and potential licence restrictions (Maxwell et al., 2023). International guidelines recommend starting journeys above a minimum glucose level, yet offer little direction on how to monitor or respond to changes while driving (Trawley et al., 2022). CGM can provide real-time alerts to help prevent hypoglycemia, but its role while driving remains unclear, with a single experimental study suggesting CGM alerts can reduce hypoglycemic driving (Maeda et al., 2025). Evidence from real-world driving is limited.

With increasing CGM uptake and new road rules in Australia permitting mounted medical devices, there is an opportunity to examine how well diabetes technology aligns with the regulatory environment. In 2023, the Australian Road Rules were updated through the national model law framework to modernise device use provisions. Critically, Rule 304H(2)(e) now permits use of inbuilt or mounted devices for "a function on the device designed to monitor the driver's behaviour or condition" (National Transport Commission, 2023). This provision creates a regulatory pathway for CGM use while driving, provided the device is mounted or integrated into the vehicle's systems.

This raises a key question: has diabetes technology kept pace with this regulatory opportunity? To explore this, we surveyed drivers with diabetes on glucose-lowering medication, directly asking them about the issues they encounter when trying to use CGM while driving.

Conference theme
This work directly addresses the ARSC2026 theme *From Evidence to Action: Shaping a Brighter Future* by translating survey evidence from over 1,200 drivers into actionable recommendations for CGM manufacturers, road safety policymakers, and driver education programs. It demonstrates that regulatory frameworks have progressed, but that technology design and driver awareness have not followed, creating an evidence-to-action gap that affects road safety for drivers with diabetes.

Method
A national online cross-sectional survey was conducted between June and August 2025 using the Qualtrics platform. Participants were Australian adults (≥18 years) with diabetes treated with glucose-lowering medication who held a valid driver's licence, recruited via paid social media advertising and a research panel. The survey assessed self-reported hypoglycemia while driving (past 12 months), CGM use patterns, perceived barriers to in-car use, awareness of driving regulations, and desired device features. Logistic regression examined associations between CGM use and reported hypoglycemia while driving, adjusting for demographic, clinical, and driving factors. Open-text responses were analysed using content analysis.

Results

Of 1,209 participants (mean age 55±15 years; 47% CGM users; 39% type 1 diabetes), 28% reported hypoglycemia while driving in the past 12 months. CGM use was associated with over three times the odds of reporting driving hypoglycemia (adjusted OR: 3.61 [95% CI: 2.29–5.68]), likely reflecting improved detection rather than increased risk.

Among CGM users, two-thirds relied on vibration or audio alerts while driving, 27% used smartwatches, and 23% used a mounted smartphone. Only 15% adjusted alert thresholds for driving. Half (50%) reported difficulty using CGM while driving, and 43% were unsure what was legally permitted. Only 36% were aware that specific laws governing CGM use while driving existed. Table 1 summarises desired features for CGM use while driving.

Table 1. Desired future features for CGM use while driving among CGM users (n = 494)

Feature desired	N	%
CGM app designed for driving	273	(55.3)
In-car dashboard interface	251	(50.8)
Audible alerts tailored for driving	242	(49.0)
Legal clarity / driver education	224	(45.3)
Smartwatch integration	170	(34.4)
Voice alerts or haptic feedback	165	(33.4)

Note. Participants could select more than one response.

Critically, the Australian Road Rules (Rule 304H) now permit use of mounted or inbuilt devices to monitor a driver's condition, yet no CGM manufacturer currently offers CarPlay or Android Auto integration, heads-up display functionality, or a driving-specific interface. Open-text responses reinforced this gap, with drivers requesting in-car display integration and voice-based glucose readouts. Notably, over a quarter of CGM users reported viewing glucose data on a smartwatch while driving, and smartwatch-based CGM monitoring was among the most desired future features. However, the monitoring exemption under Rule 304H applies only to mounted or inbuilt devices, not smartwatches. Drivers who want improved integration of CGM data on their wrist appear largely unaware that this use may not be legally supported, highlighting a disconnect between driver expectations and the regulatory framework.

Benefits to road safety

This work demonstrates that CGM improves hypoglycemia detection while driving and identifies a gap between what drivers need and what current technology provides. Updated Australian Road Rules include provisions that could support in-car CGM use, but drivers remain largely unaware of these rules and, based on participant feedback and to the authors' knowledge, no CGM manufacturer has designed a product that accommodates driving. Addressing this technology design gap could reduce undetected hypoglycemic driving episodes among approximately 485,000 Australians with diabetes on glucose-lowering medication, many of whom would be active drivers (NDSS, 2026).

Implications for policy and practice

Three implications emerge. First, CGM manufacturers should develop driving-specific interfaces that integrate with in-car display systems and include context-aware alert profiles. Second, driver education programs should inform drivers with diabetes about their existing rights under updated road rules, particularly the provision for health monitoring devices on mounted or inbuilt displays. Third, road safety agencies should continue to consider how emerging health monitoring technologies fit within distracted driving policy frameworks, recognising that these devices serve a fundamentally different purpose to entertainment or communication technologies.

Conclusions

Updated Australian Road Rules have created a regulatory framework that could support CGM use while driving, but current devices are not designed to operate within it. Drivers with diabetes report both a need for and interest in safer, driving-specific CGM solutions. Bridging this gap between regulation and technology represents a concrete opportunity to improve road safety. Future research should use objective driving data to evaluate how in-car CGM integration affects driver behaviour and safety outcomes.

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Examining public support for lower speed limits in Melbourne, Australia

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Abstract
Lower speed limits on local streets are important for better protecting vulnerable road users and achieving the objectives of increasing active transport and creating vibrant, sustainable places and communities. While lower speed limit policies have recently been promoted for local streets, especially those with high pedestrian and cycling activity, empirical evidence on public support for such measures remains limited in the Australian context. This research investigates the extent of public support for lower speed limits on local streets and identifies the key factors associated with this support. Data collected from an online survey in Melbourne, Australia (n = 500) were analysed using an advanced modelling technique, the Partial Least Squares Structural Equation Modelling (PLS-SEM). Participants were moderately supportive of 40km/h speed limits on local streets, but less supportive of 30 km/h speed limits. Results supported campaigning for lower speed limits on traffic safety and environmental grounds, and applying incremental changes in specific local areas.

Introduction
Long-term strategic planning of road networks is shifting from traditionally car-centric approaches to models that more safely and equitably accommodate all road users, including pedestrians and cyclists. Examples of this are seen in Australian jurisdictions, including New South Wales, Queensland and Victoria, adopting Movement and Place frameworks (e.g., TfNSW, 2023; Vic DoT, 2019). A key part of this shift is the introduction of lower (e.g., 30-40km/h) speed limits in urban areas with high-level pedestrian and/or cyclist activity. Research shows that lower urban speed limits significantly improve traffic safety and also generate environmental benefits (reduced emissions, noise pollution, fuel consumption), while having generally minimal negative (and sometimes positive) effects on travel times and congestion (Yannis & Michelaraki, 2024).

Public acceptance and support for these measures is important for implementation and achieving the objectives of increasing active transport, better protecting vulnerable road users, and creating vibrant, sustainable places and communities. Public support for lower urban speed limits and associated measures has been explored in previous research using surveys and other methods. Several studies suggest that public acceptance and support for relevant policies tend to increase over time (Appleyard & Lintell, 1972; Maisel et al., 2021; Williams et al., 2022), which can be assessed using pre- and post-intervention surveys (e.g., 12 months after implementation). Opposition and resistance to such changes have also been explored from multiple disciplinary perspectives (Gössling, 2025; Hoffmann et al., 2017; Murtagh et al., 2014). Habit-related factors, self-identity, and psychological attachment to cars are among the key drivers of such resistance, according to these studies.
Nevertheless, empirical evidence on public support for lower speed limits and associated factors remains limited, especially in the Australian context.

The current research, therefore, aims to investigate the level of public support for lower speed limits in Melbourne, Victoria, including identifying factors associated with higher and lower levels of support.

Conference theme
This research directly supports the conference theme by generating robust empirical evidence on public support for lower speed limits. By identifying the key barriers and facilitators shaping public support, the findings equip policymakers and transport authorities with practical insights to translate evidence into effective engagement, implementation, and communication strategies, ultimately contributing to the reduction of deaths and serious injuries on local streets.

Method
An online survey (n = 500) was conducted to examine public support for several sustainable transport policies, including lower speed limits. The survey was administered by a market research firm, Ipsos, in June 2025. Targeted participants included adults aged 18 years and older who reside in Greater Melbourne. The survey was

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approved by the University's ethics committee (HEC25160). Gender distribution was approximately balanced, with 49% identifying as male and 51% as female. About 12% of the sample aged 18–25 years, 21% aged 26–35 years, 28% aged 36–50 years, 21% aged 51–64 years, and 19% aged 65 years and over, indicating a broad age distribution. Half of the respondents (50%) were employed full-time, 18% were employed part-time, 5% were employed on a casual basis, and 2% identified as students. 57% of respondents reported using a car on a daily basis, followed by walking (at least 1 km; 48%), public transport (14%), and bicycle/e-bike (4%).

A 5-point scale (1 = Strongly oppose and 5 = Strongly support) was used to measure support for lower speed limits, using two items: supporting 40 km/h and 30 km/h on all local streets. Similarly, a 5-point scale (1 = Strongly disagree and 5 = Strongly agree) was used to measure other constructs such as Car Driver Identity, Environmental Concerns, Perceived Traffic Safety, and Perceived Traffic Congestion. Car Driver Identity was measured using one item: "I identify with car drivers". Environmental Concern items included "Motor vehicles are a significant contributor to air pollution", "Environmental protection will help me to have a better quality of life", and "Environmental protection benefits everyone". Perceived Traffic Safety included three items: "Traffic crashes are a significant concern around my neighbourhood", "Bicycle crashes are one of the primary concerns in my city", and "Pedestrian crashes are one of the primary concerns in my city". Perceived Traffic Congestion was measured with "Traffic congestion is severe around my neighbourhood".

A Partial Least Squares Structural Equation Model (PLS-SEM) was used to examine how other constructs influenced support for lower speed limits on local streets. PLS-SEM is appropriate for modelling multiple latent constructs, including single-item constructs. The modelling was conducted in the R statistical environment with the SEMinR package. Internal consistency was examined using Cronbach's α, and convergent validity was evaluated through the Average Variance Extracted (AVE). The statistical significance of the structural path coefficients was tested using a bootstrapping approach based on 5,000 samples.

Results

Overall, there was moderate (42%) support for the introduction of 40 km/h speed limits on all local streets, including 13% strongly supportive and 29% somewhat supportive of this measure. Around one quarter (24%) were neutral, while one third (33%) were opposed, including 17% strongly opposed and 16% somewhat opposed. There was less support regarding the introduction of 30 km/h speed limits on all local streets. The majority (54%) of participants opposed this policy, either strongly opposed (32%) or somewhat opposed (22%), while 18% were neutral. This 30 km/h speed limit was only supported by 27% of participants in total, with 19% somewhat supportive and 8% strongly supportive. In addition, most participants expressed moderate or strong concern about traffic congestion, safety, and environmental impacts of motorised private transport.

Results of the PLS-SEM model are summarised in Figure 1, focusing on the relationships between five constructs (Perceived Traffic Safety, Perceived Traffic Congestion, Car Driver Identity, Age, and Environmental Concerns) and support for lower speed limits. This model explained about 24.2% of the variance in the support for lower speed limits overall (R-squared = 0.242), with only statistically significant predictors ($p < 0.05$) reported. Regarding multiple indicator constructs, both the Environmental Concerns and Perceived Traffic Safety constructs showed strong reliability (Cronbach's $\alpha = 0.80$ and 0.739, respectively) and acceptable convergent validity (AVE = 0.571 and 0.506, respectively). The Support for Lower Speed Limits construct also showed strong reliability (Cronbach's $\alpha = 0.790$) and good convergent validity (AVE = 0.653).

The public support for lower speed limits on all local streets was associated most strongly with environmental concerns (path coefficient = 0.294, 95%CI: 0.191 to 0.395), followed by perceived traffic safety (path coefficient = 0.215, 95%CI: 0.098 to 0.338). Resistance to lower speed limits was evident in negative associations with three constructs, including perceived traffic congestion (path coefficient = -0.157, 95%CI: - 0.262 to -0.054), identification with car drivers (path coefficient = -0.208, 95%CI: -0.303 to -0.109), and older age (path coefficient = -0.171, 95%CI: -0.258 to -0.08). This opposition was strongest in relation to identification with car drivers, which could generally be expected.

Benefits to road safety

Lower speed limits save lives, and an improved understanding of public support and associated factors will inform policy and practices in planning and implementation stages.

Implications for policy and practice

The findings of this research suggest value in promoting and campaigning for lower speed limits (30-40km/h) on local streets on environmental grounds, followed by traffic safety concerns. Perceived traffic congestion negatively affects public support for lower limits. However, there is some evidence that lower speed limits do not substantially increase traffic congestion. This should be clarified and/or demystified in publicity campaigns.

The literature regarding habits and willingness to change was insightful for interpreting some of these results, showing

that emotional and habit-related factors may be a greater driver of (or impediment to) behaviour change than rational principles. As stated above, public acceptance and support for relevant policies including reduced speed limits tends to increase over time. Specifically, Williams et al. (2022) demonstrated that support for and compliance with lower (32km/h) speed limits increased 6 and 12 months after implementation in Edinburgh, UK. These authors also note, however, that effectively communicating the benefits of speed policy changes to road users and the public remains a key challenge.

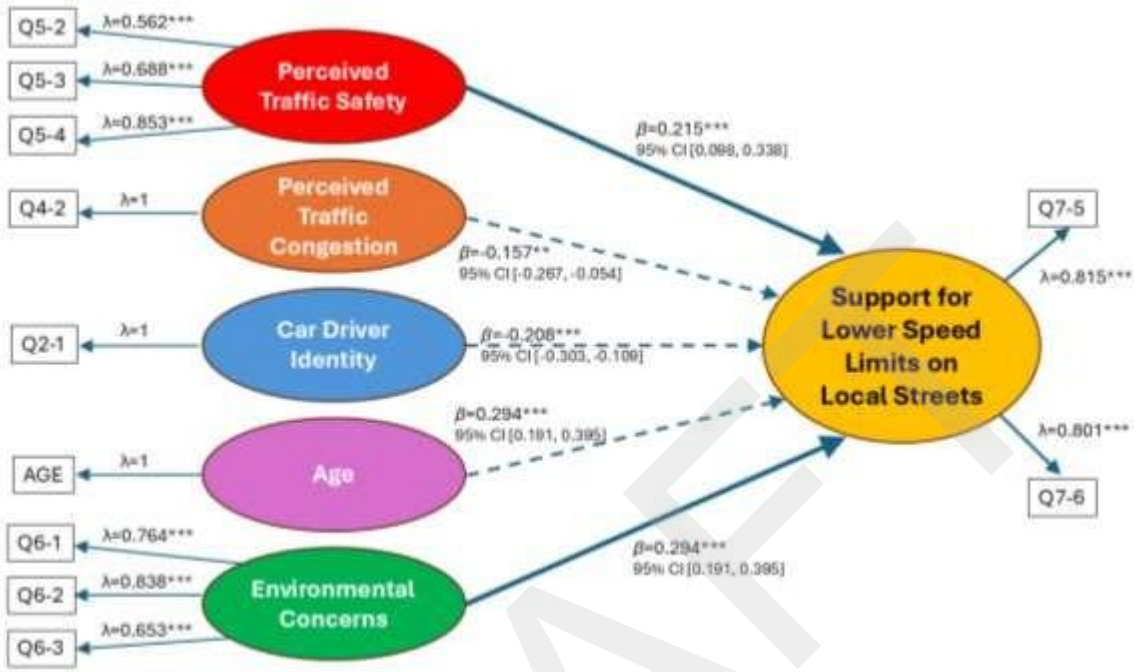

Figure 1. Combined PLS-SEM model of support for lower speed limits on all local streets

Conclusions

This research highlighted that participants were moderately supportive of the 40km/h speed limit on local streets, but less supportive of the 30 km/h speed limit. Results supported campaigning for lower speed limits on traffic safety and environmental grounds, and applying incremental changes in specific local areas. A road user perceptions indicator regarding support for policies including lower speeds may be used in the performance indicators for relevant frameworks such as Movement and Place, which remains a topic for further research

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A case study of cyclist passing distance measurement tools

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Abstract
Cycling is a popular recreational activity and form of transportation, with significant health and environmental benefits. However, cycling also comes with dangers as cyclists are less protected than other road users, particularly during passing event by vehicles. A literature review and comparative analysis was conducted on the main sensor technologies used in cyclist passing distance research. The literature review found that there was a wide range of sensor characteristics (operating frequency, range, field of view) and overall capabilities used in cyclist passing distance research. A need for more transparent reporting of sensor specifications and data processing algorithms was also noted to improve trust, interpretability, and replicability. The on-road case study found that LiDAR potentially captured more passing events at high speed (>60km/h) than ultrasonic sensors. This research highlights both the advantages of high-accuracy sensors and the limitations of commonly used measurement tools, aiming to inform more reliable and interpretable data collection in the field.

Background
Cycling is a popular recreational activity due to its health, social, environmental, and economic benefits. However, cyclists are less protected than motor vehicle occupants and therefore face a greater risk of severe injury (Beck et al., 2019). Close passing by vehicles is a significant safety concern for cyclists, and can create anxiety that discourages cycling participation (Feizi et al., 2021). As a result, accurately measuring passing distance is an important component of cycling safety research.

The methods and technologies used to measure passing distance must be carefully considered to ensure reliable and meaningful results. This raises important questions about which distance-sensing technologies are most appropriate and what additional data should be collected to support accurate interpretation of passing distance measurements. Despite the growing body of research examining factors such as vehicle speed, road type, and rider characteristics, limited attention has been given to the validity, accuracy, and comparative performance of the sensors used to measure cyclist passing distance (Louro et al., 2023).

Most studies have primarily relied on two sensor technologies: ultrasonic and LiDAR. While other approaches, such as camera-based systems, have been used, most of the literature focuses on these two sensor types (Rubie et al., 2020, Mackenzie et al, 2019). However, reporting inconsistencies, such as differences between sensor operating frequencies and vague details about the processing of captured data, can limit comparability and reproducibility across studies. Additionally, LiDAR sensors physically operate in a different way to ultrasonic sensors (higher sampling rate and narrower field of view), which may affect accuracy, particularly in high-speed passing scenarios.

Using the right tools and equipment in research is crucial for trustworthy results, particularly in naturalistic studies that rely on measurements from bespoke sensor-based tools where differences in accuracy, sampling rate, and calibration can significantly influence the outcome.

Conference theme
This presentation will address the theme of from evidence to action by providing a critical evaluation of the current literature utilising measurement tools for cycling passing distance to inform what and how we should be using research tools in the future.

Project description
This case study will present the findings from a literature review, and results from a comparison of two studies that collected passing distance data on the same road network using different types of sensors.

An in-depth literature review was conducted with a focus on location, study design, participant demographics, sensor type, sensor specifications, and sensor placement. The selection criteria included 1) full original articles published in peer-reviewed journals; 2) primary outcome was measuring passing distance from cyclists; 3) an external sensor was deployed or developed on a bicycle to measure distance from cyclists and vehicles; 4) an instrumented bicycle was used and 5) the study was conducted in a naturalistic (or quasi-naturalistic environment). Source articles were excluded if 1) they were not published in peer-reviewed journals; 2) did not evaluate passing distance from cyclists as a primary

outcome; 3) did not involve an instrumented bike or where an external measurement device was not used and 4) where the full text was unavailable.

A case study on comparing the output of the two main sensor types used in passing distance research (ultrasonic and LiDAR) was conducted using data from two studies conducted in the city of Canberra, Australia over two years (2018 and 2023). Both studies were conducted in a similar way, with a data collection device incorporating either an ultrasonic or LiDAR sensor fitted to the bicycles of volunteer participants.

Findings

The literature review found a total of 15 articles which met the inclusion criteria. The literature shows that sound sensors (ultrasonic sensors) (n=12) and light sensors (LiDAR) (n=3) are the main sensor types which are used to measure vehicle passing distances.

The review found that there was a wide variation in data collection methodologies, locations, road and surface types, as well as demographics. Additionally, there was a wide range of passing events captured across the studies with some reporting as little as 100 events, whilst other studies captured over 46,000 events. A larger number of events provided scope for more detailed analysis. Although, studies with a small number of events were typically focussed on specific complementary factors where more manual data collection methods were required (e.g., asking rider's impressions about each passing event).

A key concern raised from the literature review was the lack of specification details regarding the sensors that were used. Sensor specific methodological factors such as sensor field of view, sensor placement, and capability in various weather or environmental conditions, which can potentially impact both the accuracy of passing distance measurements and the validity of results, were not always reported or well detailed.

Sensor range was another key specification reported in the literature, showing considerable variation across the screened studies. The mean maximum range of ultrasonic sensors is 503 cm (±232cm) and the mean range for the LiDAR sensors is 1700 cm (±1300cm). This indicates that LiDAR sensors used in lateral passing distance studies generally provide a substantially longer sensing range compared to ultrasonic sensors. Although, it should be noted that 400cm is typically sufficient to detect a vehicle passing in an adjacent lane.

The literature review also highlighted the range of sampling rates used across the literature. With the minimum reported sampling rate being 10Hz up to 70Hz. It should be noted that the sampling rate employed was often set lower than the sampling capacity of the individual sensors, which may be due to computational constraints of the processing techniques used. However, lower sampling rates come with a trade-off whereby accuracy may potentially be decreased, or segments of a passing event may be missed, particularly at higher passing speeds.

This potential trade-off was explored in the case study comparing ultrasonic to LiDAR sensors, which had a sampling rate of 20Hz and 50Hz respectively. Across both studies there were a total of 51,678 passing events captured across the same road network. Descriptive statistics for these passing events are presented in Table 1, indicating a similar proportion of passing events captured in high and low speed environments, but that higher vehicle speeds were associated with wider passing distances in the study using a LiDAR sensor operating at 50Hz.

Table 1. Descriptive statistics for passing distance data collected in Canberra across the two rounds of data collection

	2018 data	**2023 data**
Total passes:	16,476	35,202
Low speed passes (speed zones 60 km/h or below)	4,064 (24.7%)	10,356 (29.4%)
High speed passes (speed zones above 60 km/h)	10,959 (66.5%)	22,377 (63.6%)
Mean passing distance (cm):	187.7	194.8
Low speed mean passing distance	174.0	173.4
High speed mean passing distance	192.2	205.0

Further analysis, shown in Figure 1, indicates that the two sensor types capture a similar proportional spread of passing distances on low-speed roads. However, on high-speed roads, the LiDAR sensor (with a higher data capture rate) appears to be more effective at detecting passing events at greater distances than the ultrasonic sensor.

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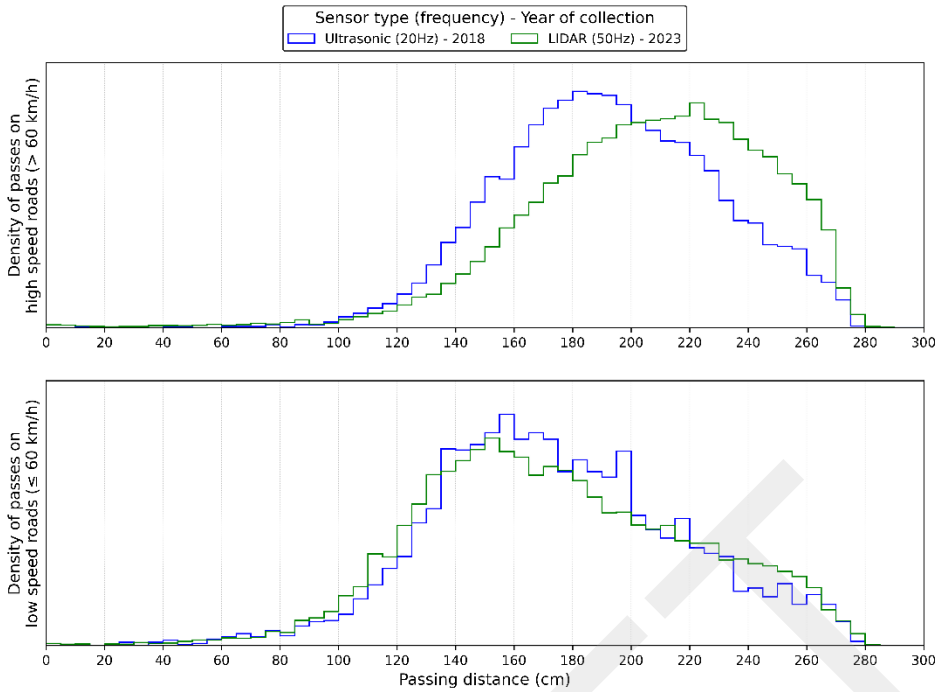

Figure 1. Comparison of passing distance events by sensor type in Canberra, 2018 and 2023

Benefits to road safety

This research contributes to road safety by highlighting the advantages and limitations of different passing-distance measurement tools. The use of higher-accuracy instruments such as LiDAR, is more likely to provide a reliable representation of the risks faced by vulnerable road users, such as cyclists.

Implications for policy and/or practice

The work presented here has implications for future research into passing distances of cyclists when being passed by vehicles on real roads. Accurate measurement capture of passing distance is vital to having an accurate picture on the roads of how close vehicle are to cyclists. This work highlights the need to implement highly accurate sensors where possible, whilst also understanding and acknowledging the limitations of commonly used sensors in the field. This research hopes to highlight the limitations of commonly used sensors.

Conclusions

This study presents the first comprehensive literature review of measurement tools used to capture cyclist passing distance events. The findings suggest that the higher data capture frequency of LiDAR sensors may offer improved measurement accuracy compared with ultrasonic sensors at higher passing speeds. However, future research should balance the benefits of increased accuracy with the need for cost-effective data collection, as ultrasonic sensors remain more accessible and affordable, while LiDAR systems may be cost-prohibitive for some research applications.

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Evaluating changes in mandatory fitness-to-drive reporting in South Australia

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Abstract
This study investigated the impact of changes to the mandatory fitness to drive reporting requirements for South Australian drivers aged 70 years and over. The requirement for mandatory medical assessments for drivers aged 70 was removed in 2014 and replaced by self-assessment for drivers aged 75 and above. The current study analysed licensing, population and crash data from 1997-2023 and examined trends in drivers aged 18-59 (baseline group), 60-69 and 70-100. Changes in licensing rates, medical suspensions, and crash rates, including pedestrian and mobility scooter crashes, were analysed before and after the reporting changes for the affected age groups. The study found an increase in licence suspensions on medical grounds for older drivers post licensing changes and a decrease in casualty crash involvement. Findings indicate that removing mandatory age-based fitness to drive assessments for older drivers in South Australia did not lead to adverse road safety outcomes.

Background
With an aging population and rising licensing rates, more older adults are likely to remain active drivers to maintain their mobility and independence.
Previous research suggests that older drivers do not exhibit higher crash rates than other age groups (e.g., Baldock & McLean, 2005) but, as people age, they become more likely to develop medical conditions that may increase the risk of crash involvement. Certain sub-groups within the older population, particularly those with conditions like vision impairment, cognitive decline, or musculoskeletal disorders, may face greater risk (Falkenstein et al., 2020). These conditions can impair key driving abilities such as reaction time, decision-making, and physical control of the vehicle (Baldock et al., 2016).
Historically, South Australia required all drivers to undertake a fitness to drive assessment conducted by their doctor annually, from the age of 70 onwards. From the 1st of September 2014, these requirements were removed and replaced in 2015 with an annual self-assessed form for licensed drivers aged75 years or more.
It was anticipated that, following the removal of mandatory doctor-based assessments in 2014, more older drivers would remain licensed, potentially resulting in an increase in older driver crashes. With nine years of data since the reporting change, it was considered timely to assess crash data and medical suspension rates to evaluate the impact of fitness-to-drive assessment changes on road safety.

Conference theme
This work aligns with the conference theme of 'From Evidence to Action: Shaping a Brighter Future'. By critically evaluating crash and medical suspension data in relation to the new policy, we were able to determine whether the policy change has had any effects on road safety outcomes. By examining changes to mandatory fitness-to-drive assessments, we have an opportunity to ensure that we are responding to the evidence and making informed decisions that protect both older road users and the wider community.

Method

Licensing data
Data were extracted from the South Australian vehicle and registration licensing system, the Transport Regulation User Management Processing System (TRUMPS) to obtain the following data: licence number, date of birth, listed medical conditions, medical suspension, refusals, and disqualifications for each driver (only drivers with a C class licence were included). Three driver age groups were used for the analysis in the report: 18-59, 60-69 and 70-100. The 18-59 and 60-69 driver age groups were included in this analysis to act as baseline/comparative groups (and comparative analysis for all 3 age groups will be included in the presentation).

Medical suspensions
Medical suspensions were also extracted from TRUMPS for all age group categories for the years 1997-2023. Medical suspensions were categorised as either suspensions or refusals and, within each category, there were further sub-categories under which medical suspensions were classified: a) medical suspensions, b) medical not returned or c) self-assessment not returned (only present after 2014).The mean number of days by medical suspension type was calculated for those over 70 years and where there was an end-date for the medical suspension. To understand the patterns and trends of medical suspensions pre-policy change and post-policy change, it was important to look at the distribution of

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medical conditions contributing to medical suspensions. The recorded reason for a medical suspension was extracted from the licensing data and was aggregated into 10 subcategories: cardiovascular, neurological, diabetes, epilepsy, hearing, musculoskeletal, psychiatric conditions, vision, sleep disorders and stroke.

Injury and fatal crashes

All injury and fatal crashes for drivers 18 years and over between 1997-2023 were extracted from the South Australian Traffic Accident Reporting System (TARS). Additionally, pedestrian crashes involving injury and gopher/mobility scooter crashes for people 70 years and over were also extracted to understand the impact of the changes in mandatory fitness to drive requirements. Pedestrian and gopher/mobility scooter crashes were selected for analysis in this study as these are forms of transportation which may be alternative options for older people when or if their licence is suspended (e.g., on medical grounds).

Comparative analysis

The impact of changes in the mandatory medical requirements for older drivers focused on comparing pre-policy change (1997-2014) and post-policy change (2015-2023) years by age group. A piecewise regression was used to analyse the pre- and post-policy impact on medical suspensions and the Welch's t-test was used to measure pre- and post-policy change impacts on injury and fatal crash rates.

Results

There was an increase in the mean annual percentage of drivers suspended on medical grounds aged 70-100 post-policy change (M=4.19%, SD=1.03%) when compared to pre-policy (M=2.41%, SD=0.82%), which a Welch's test found to be a statistically significant increase ($t_{(13.2)}$= -4.49, p <0.001) as seen in Figure 1.

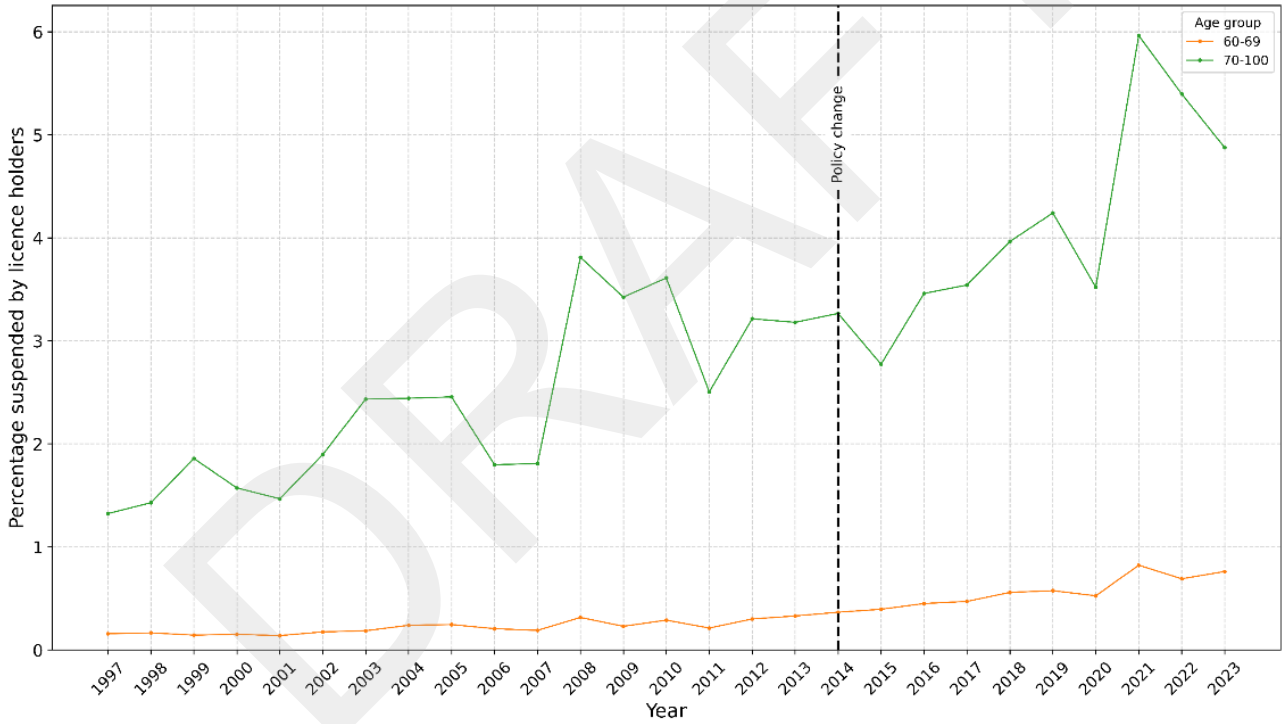

Figure 1. The percentage of licensed drivers by age group (60-69 and 70-100 years) suspended on medical grounds by year
Source: Author generated

A piecewise regression analysis examined whether the trend of medical suspensions per 10,000 licence holders (only for the 70–100-year-old age group) followed a similar upward trend for the post-policy period when compared to the pre-policy period. Results of the regression model explained a substantial proportion of the variance of medical suspensions per 10,000 licence holders (Adjusted $R^2 = 0.66$), presented in Figure 2. The model showed no statistically significant change in trend from the break point (the 2014 policy change represented by the red dashed line) of medical suspensions post-policy change compared to pre-policy change. The trend post-policy change remained consistent and was not significantly different when compared to the trend pre-policy change ($\beta = 13.01$, $p= 0.14$). This suggests that medical suspension rates were rising prior to the policy change and that this continued post-policy change.

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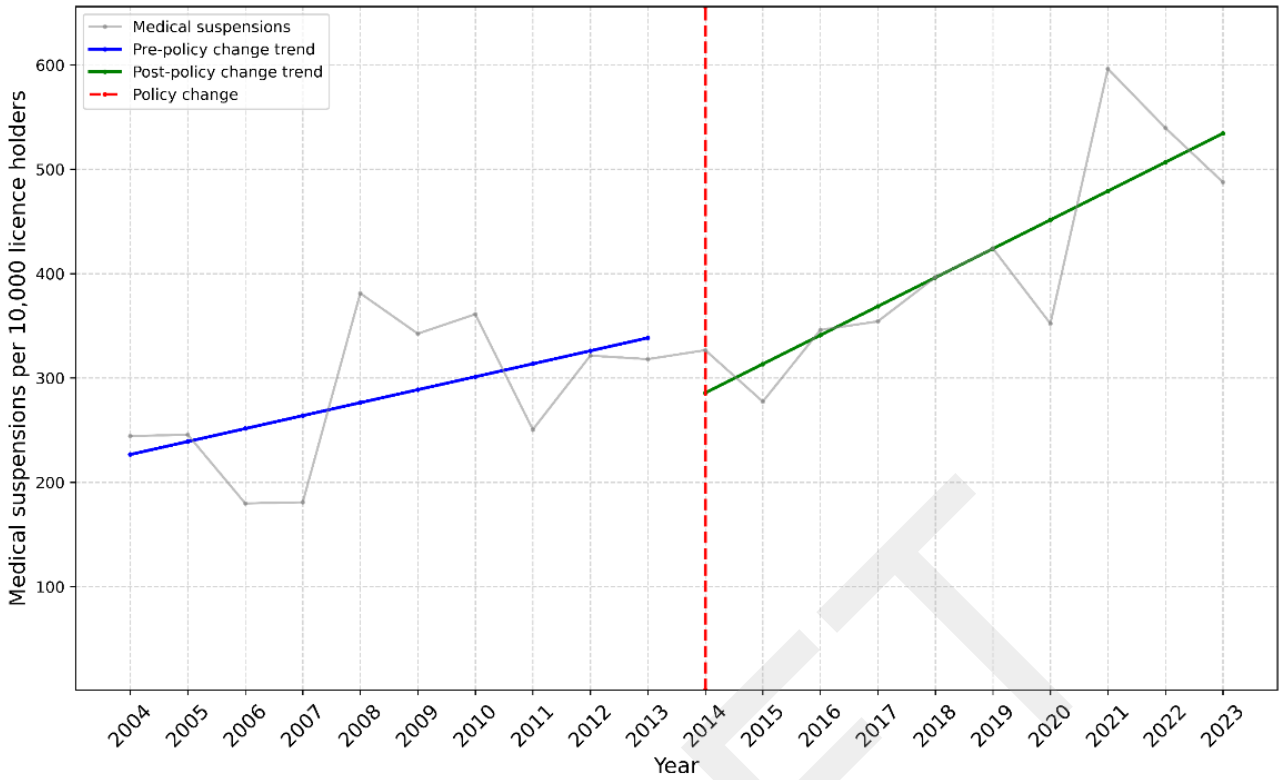

Figure 2. Piecewise regression model for medical suspensions showing the model of best fit for the pre-policy change (blue line) and post-policy change (green line) separated by the policy change which occurred at 2014 (dashed red vertical line)
Source: Author generated

There was a mean decrease in the rate of injury crashes involving drivers aged 70-100 post policy change (M= 0.35 %, SD= 0.06) when compared to pre-policy change (M= 0.71%, SD= 0.27), which a Welch's *t*-test found to be a statistically significant change ($t_{(20.4)}$= 5.39, p<0.001). There was a mean decrease in the annual rate of fatalities per 10,000 licence holders for drivers aged 70-100 post-policy change (M=0.97, SD=0.38) when compared to pre-policy change (M=1.90, SD=1.23). This decrease was found to be statistically significant using a Welch's test ($t_{(21.2)}$= 3.01, p <0.05).

Benefits to road safety

This evaluation suggests that current medical fitness-to-drive assessment practices in South Australia are effective in ensuring the safety of both older adults and other road users, while also maintaining the mobility and independence of older drivers.

Implications for policy and/or practice

This evaluation shows the potential effectiveness of alternative methods to annual, mandatory doctor-based assessment of fitness to drive for older adults. Despite the absence of such annual mandatory assessments, older drivers with fitness to drive issues can still be identified.

Conclusions

The removal of mandatory age-based fitness to drive assessments for older drivers in South Australia has not been found to have resulted in any road safety disbenefits. These outcomes can be taken as supportive of the changes to the medical fitness to drive policies and processes for older drivers in South Australia.

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Coordinated use of Austroads guides to support safe road transport

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Abstract
The coordinated application of the Austroads Guides to Road Design, Traffic Management, and Road Safety is critical to achieving safe, efficient and context-responsive transport. This paper synthesises the objectives and key findings of a recent guidance document that promotes a unified approach to transport facility planning, design, implementation and operation. The primary objective is to improve integration between traditionally separate professional domains and ensure that safety and mobility outcomes are addressed concurrently in the design process rather than sequentially. The paper outlines a staged framework linking strategic network planning to design, supported by core concepts including Movement and Place, Level of Service, the Safe System approach, Safe Mobility, Context-Sensitive Design and design domains. Findings highlight that early scoping decisions, speed management, and Safe System end-state thinking are central to reducing fatal and serious injury. Coordinated, risk-based and context-responsive practice is essential to achieving long-term safety objectives.

Introduction
Across Australasia, the development and management of road networks are guided by three series of documents published by Austroads: the Guide to Road Design (AGRD; Austroads 2023), the Guide to Traffic Management (AGTM; Austroads 2020), and the Guide to Road Safety (AGRS; Austroads 2024). While each Guide provides comprehensive discipline-specific direction, their application has often occurred within professional silos. There is a requirement to strengthen the integration between road design, traffic management and road safety practice to support safe and efficient transport outcomes. This paper synthesises a new report from Austroads (2026) that seeks to address this gap. Summary material from this report will be included in each guide to assist with this task.

The objective of this work is to improve mutual understanding between practitioners and to clarify how core concepts embedded within the Guides interact throughout the lifecycle of a transport facility. Rather than treating planning, design and safety assessment as discrete processes, there is a need for a unified approach in which context, objectives and safety expectations are established early and maintained throughout planning and operation.

A whole-of-life framework is presented, encompassing: (1) strategic network planning; (2) scoping; (3) concept design; (4) preliminary design and detailed design; (5) implementation; (6) operation review; and (7) redesign or reconfiguration. Importantly, the process makes continual reference to context and objectives, and is iterative rather than linear. Decisions made in later phases may require revisiting earlier assumptions, particularly where safety risks or operational conflicts emerge.

The report also identifies key conceptual foundations that must be understood collectively when applying the Guides. These include understanding of the transport facilities Context and Objectives, Movement and Place, Level of Service (LOS), the Safe System approach and Safe System End States, Safe Mobility, Context-Sensitive Design (CSD), Design Domains (Normal and Extended Design Domains), and the critical Role of Speed. Together, these concepts provide a structure for road design that aligns with mobility objectives and the elimination of fatal and serious injury.

Conference theme
This work translates established Austroads guidance into a framework that guides practitioners from strategic planning through to operation. Safety is embedded in this process, alongside key road design and traffic management requirements.

Findings

A Unified Whole-of-Life Framework
Safe and efficient transport outcomes depend on coordinated engagement with all three Guides across the life of infrastructure. Strategic network planning establishes long-term economic, social and land-use objectives. During the scoping phase, context and operational objectives are defined using Movement and Place principles, ensuring clarity regarding function, user priorities and performance expectations.

Concept, preliminary and detailed design phases progressively refine geometric layout and operational elements while continuously checking alignment with agreed objectives. Risks must be addressed in each phase of design to provide the highest possible level of safety, with the ultimate goal of zero fatalities and severe injuries. The implementation and operational review phases reinforce the need for monitoring and adaptive management. Decisions made throughout the design development process, including design exceptions, should be documented in a 'live' design report.

Along with this over-arching design approach, several key concepts are included throughout the different guides. It is important for guide users to understand these key concepts when using each Guide.

Context and objectives

A transport facility is defined by its function, users (all modes), operating environment, and role in the network, and its purpose is to serve the users. Those designing and operating the system must understand the broader environment and network around the facility, the characteristics of the users and asset management requirements.

Movement and Place and Network Operations Planning

Movement and Place is an approach that recognises that roads and streets have a dual role. They facilitate the safe and efficient movement of people, goods and services, but also function as public spaces that support activity. This concept supports network vision by classifying corridors according to movement importance and place intensity, so that practitioners can set explicit performance targets for different user groups. Network Operations Plans (NOPs) are a strategic framework used by road agencies to manage infrastructure, balancing demands from different road user groups to meet community goals. When Movement and Place is embedded within NOPs, this guides speed setting, modal prioritisation, corridor and intersection treatments and land-use integration. A key finding is that corridor function must be defined before design decisions are made; otherwise, operational conflicts and safety compromises arise.

Level of Service and Multi-Modal Performance

Level of Service (LOS) is the concept of a letter-graded quality of service, that ranges from A (excellent) to F (poor). It relates to how a customer or road user perceives performance relating to various operational targets such as safety, efficiency, amenity, accessibility, and equity. LOS should extend beyond vehicle delay to incorporate safety, accessibility, amenity and equity across modes. LOS targets derived from Movement and Place classifications provide transparent benchmarks for evaluating options. This reduces ad-hoc decision-making driven solely by congestion concerns or pressure from a single user group and aligns operational performance with strategic intent.

The Safe System and Safe Mobility

A central safety finding is that mobility must operate within survivable crash-force limits. The Safe System approach, embedded across the Guides, recognises human vulnerability and the inevitability that people make mistakes. Infrastructure, speeds, vehicles and road use must collectively ensure that crash energy does not exceed human tolerance thresholds. This approach aligns with national targets to eliminate fatal and serious injuries by 2050, backcasting interim targets to meet this objective based on an understanding of likely vehicle safety design, infrastructure provision and required speeds.

The Safe Mobility concept reframes the traditional tension between safety and efficiency. Rather than adding safety measures after mobility objectives are met, practitioners must first define a safe operating environment and then optimise mobility within this.

Context-Sensitive Design and Design Domains

Context-Sensitive Design (CSD) is presented as an iterative process that integrates engineering judgement, stakeholder expectations and agreed performance objectives so that the road design responds to environmental, economic, policy and social contexts. The Guides are not specifications but support design decisions. Design reports are critical in documenting trade-offs, design exceptions and safety mitigation strategies.

The concepts of Normal Design Domain (NDD) and Extended Design Domain (EDD) are examined in relation to safety risk. Use of EDD values may introduce additional risk and must be justified with mitigating measures. Importantly, NDD compliance does not equate to optimal safety; Safe System performance may require values outside traditional domains.

Role of speed

Speed is identified as the connecting variable between infrastructure design, operational performance and injury severity. Target speed must align with corridor function as determined through Movement and Place classification. Operating speed must then be influenced through geometric design, traffic control and enforcement to match this target. Survivable impact thresholds, approximately 30 km/h for pedestrian collisions, 50 km/h for side impacts, and 70 km/h for head-on crashes, provide boundary conditions for safe design. Where infrastructure cannot support higher speeds safely, speed reduction is the appropriate interim measure. The paper notes persistent mismatches between speed, design and land use across the existing network and highlights the need for stronger integration of speed management policy and infrastructure planning.

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Conclusions

The coordinated use of the Austroads Guides is a critical requirement in delivering transport systems that are both efficient and aligned with Safe System objectives. Safety, mobility and place outcomes cannot be optimised when considered in isolation. A unified, whole-of-life approach based on an early definition of context and objectives enables consistent decision-making across planning, design, implementation and operation.

Key conceptual linkages are necessary. Movement and Place is needed to define corridor function, and LOS to translate strategy into measurable targets. Safe System and Safe Mobility are required to establish safety boundaries, CSD to manage constraints, and design domains to understand risk implications of geometric choices. Speed acts as the integrating variable linking these concepts.

Achieving long-term elimination of fatal and serious injury by 2050 requires proactive, risk-based approaches, involving multi-disciplinary practice. Coordinated application of the Guides provides the structural framework necessary to deliver this road safety objective while maintaining network efficiency and community value.

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Indonesian crash models and analysis methods

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Abstract

Indonesia faces substantial road safety challenges due to its large population, rapid motorisation, the high prevalence of vulnerable two- and three-wheeled road users, and the poor condition of many roads. As in many low- and middle-income countries, the true scale of the problem is difficult to quantify because historical crash data are affected by incomplete reporting and low reporting rates. To support systematic identification and prioritisation of safety treatments, predictive analysis tools based on safety performance functions (crash prediction models) were developed for the national highway network. These include safety performance functions for vehicle-only crashes and crash rates for pedestrian–vehicle crashes, incorporating region, adjacent land use, road type, population density, and traffic volume. The resulting safety performance functions and crash rates were used to produce crash-risk maps (from low to high risk) for motor vehicles (including powered two-wheelers) and pedestrians respectively across the national highway network of 47,000 km.

Introduction

Indonesia experiences a relatively high number of road deaths, with more than 30,000 fatalities each year (GRSF, 2023). This is compounded by rapid population growth and year-on-year increases in motorcycle registrations. As in many low- and middle-income countries (LMICs), most crashes involve vulnerable road users—particularly two- and three-wheelers (approximately 75%) and pedestrians (approximately 15%). Crash reporting rates are generally low, especially for non-fatal crashes, and many reports are incomplete; crash locations can also be recorded inaccurately. Further details on Indonesian crash statistics are provided by Suthanaya (2016), Jusuf etal. (2017), and Widyastuti etal. (2020).

In countries with extensive high-risk road networks but low crash reporting rates, a key challenge is determining which corridors to prioritise safety treatments. Safety performance functions (SPFs), or crash prediction models, help identify higher-risk parts of the network and provide an alternative to relying purely on historical crash data for individual road segments, which are often incomplete and inaccurate. SPFs are widely used in many developed countries, typically alongside historical crash data. This presentation will outline the SPFs and pedestrian crash rates that have been developed for Indonesia and the maps that show the high-risk road links.

Theme: A key first step in any road safety program is to use evidence, in this case form SPFs, to identify which parts of the transport network should be prioritised for road safety improvement first. This ensures that limited road safety funding is spent where it can achieve the greatest reduction in road deaths and serious injury.

Method

In this study, generalised linear models (GLMs) were developed for vehicle- and motorbike-only crashes (referred to as vehicle crashes). GLMs were first introduced to road-crash studies by Maycock and Hall (1984) and were further developed by Hauer et al. (1989). The R statistical software was used to estimate relationships between the mean number of crashes (dependent variable) and a set of explanatory variables, including traffic flows, road type, adjacent land use, and province group. Separate crash rates were also developed for pedestrian crashes. For this study, the generalised linear models take the following form:

$$\textbf{Predicted number of Fatal and Serious Injury Crashes (3 years)} = a \times d \times AADT^{b} \times Length_KM^{c} \quad \textbf{(1)}$$

Where:

a, b, and c are model parameters
d is the calibration factor for each region (with the reference region being Group 1 in Java)
AADT is the annual average daily traffic volume for the road segment
Length-km is the length of each road segment (in kilometres); where possible, 100 m sections were aggregated

The model error structure was specified as either Poisson or negative binomial. A Poisson model is appropriate when the variance of crash counts is approximately equal to the mean across most of the explanatory-variable range. In practice, crash-count data are often overdispersed (variance greater than the mean), in which case the negative binomial

model is more suitable. The negative binomial distribution can be interpreted as a Poisson–gamma mixture and is commonly parameterised using k and μ, where k, along with coefficients b_0, …, b_n, is estimated from the data. More detailed explanations are provided in Wood and Turner (2007), and Hauer et al. (1989). The Akaike information criterion (AIC) was used to select the most appropriate model. Model goodness-of-fit was assessed using the deviance function (G^2 statistic).

Results

Safety Performance Functions (Vehicle-only)

For vehicle mid-block sections (excluding major intersections), a total of 21 safety performance functions (SPFs) have been developed using data from 70% of national roads (with the remaining 30% being used to validate the models). Table 1 presents the flow-only models developed for a range of road types (e.g., urban 2-lane, 2-way undivided (22UD)) across four land-use types (urban, rural, and rural speed roads with high housing and shopping access). The models incorporate different attributes (G1 to G4), which represent parameters for the provincial groups. These models enable the predicted number of reported fatal and serious injury (FSI) crashes over a 3-year period to be estimated. Across these two categories (and most other models), the trend is similar: as AADT increases initially, the predicted FSI crash risk increases steeply, then the rate of increase tapers as average annual daily traffic increases further, likely due to congestion. Validation of the vehicle models (using the remaining 30% of the network data) generally showed good validation, except where sample size for a road stereotype was small. The models generally fit better for Java than the other island groupings.

Table 1. - SPF attribute values

Land use and Stereotype combination	SPF Used	e^a	b	c	d (G1)	d (G2)	d (G3)	d (G4)
True_Urban_22UD	True_Urban_22UD	0.113	0.32721	0.92613	1	0.678	0.333	0.737
True_Urban_42UD	True_Urban_42UD	0.55	0.1817	0.9832	1	1	1	1
True_Urban_42D	True_Urban_42D	0.29	0.07247	0.89759	1	0.291	1.275	2.769
True_Urban_4+2D	True_Urban_4+2D	0.29	0.07247	0.89759	1	0.291	1.275	2.769
True_Rural_22UD_LR	True_Rural_22UD_LR	0.0193	0.55659	0.77679	1	0.915	0.573	0.32
True_Rural_22UD_HR	True_Rural_22UD_HR	0.00488	0.72452	0.695	1	0.85	0.407	0.161
True_Rural_42UD	True_Rural_42UD	0.0664	0.4296	1.0288	1	1	1	1
True_Rural_4+2D	True_Rural_4+2D	0.0116	0.5895	1.0168	1	1	1	1
Rural_Housing_22UD_LR	Rural_Housing_22UD_LR	0.0298	0.4778	0.9915	1	1.016	0.599	0.433
Rural_Housing_22UD_HR	Rural_Housing_22UD_HR	0.00174	0.7969	1.0956	1	1.046	0.725	0.282
Rural_Housing_42UD	Rural_Housing_42UD	0.0664	0.4296	1.0288	1	1	1	1
Rural_Housing_4+2D	Rural_Housing_4+2D	0.0116	0.5895	1.0168	1	1	1	1
Rural_Shopping_22UD_LR	Rural_Shopping_22UD_LR	0.133	0.3424	0.9718	1	0.978	0.571	0.303
Rural_Shopping_22UD_HR	Rural_Shopping_22UD_HR	0.0182	0.5329	1.1695	1	1.537	0.698	0.161
Rural_Shopping_42UD	Rural_Shopping_42UD	0.0664	0.4296	1.0288	1	1	1	1
Rural_Shopping_4+2D	Rural_Shopping_4+2D	0.331	0.268	1.0467	1	0.946	0.368	0.227

Risk Maps (Vehicle Only)

While SPFs provide insight into risk profiles for individual road sections, they do not, on their own, clearly communicate how crash risk is distributed across a province, region, or country. Crash risk maps bridge this gap by clearly visualising predictive crash risk, removing the need for practitioners to use the SPF models to calculate risk directly. Figure 1 shows vehicle predictive risk across Indonesia. These maps indicate that some provinces—particularly on Java—have much higher predicted risk than others, and that built-up urban areas often have higher crash risk than their rural counterparts. Importantly, risk maps can be used to identify high-risk road sections without additional calculations.

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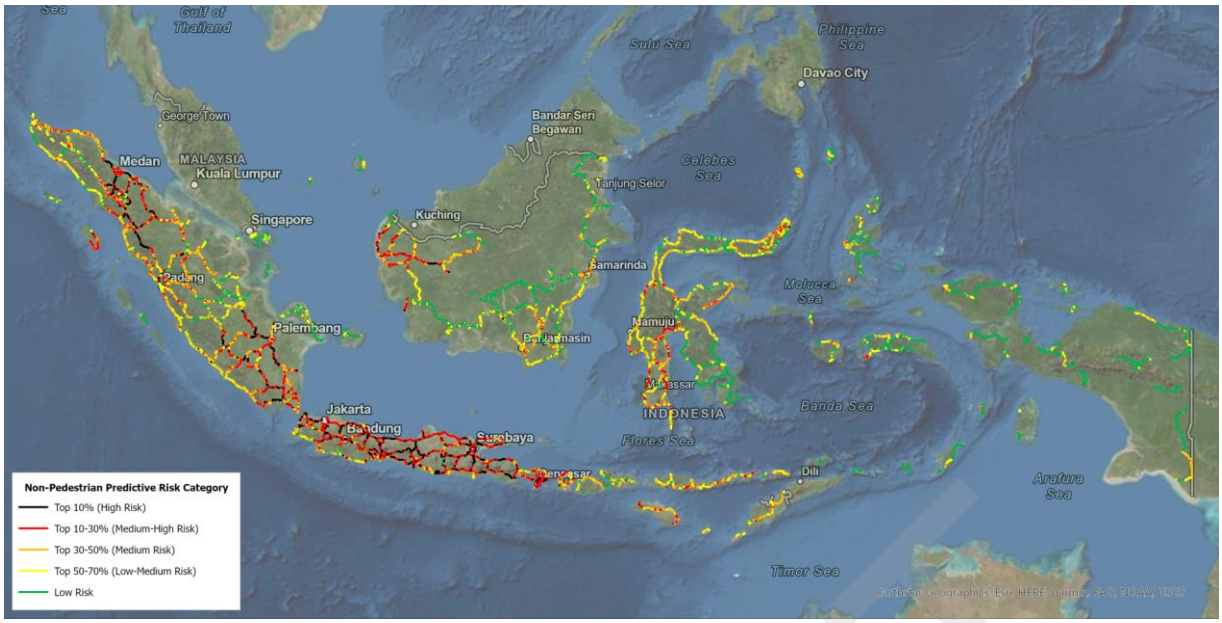

Figure 1. Vehicle Predictive Risk from SPFs (Indonesia) per kilometre

Conclusions

Prioritising limited road-safety investment is difficult in many low- and middle-income countries (LMICs) because crash data are substantially underreported and often incomplete. Safety performance functions (SPFs) and pedestrian crash rates—models that combine road and roadside characteristics with road-user volumes—address this by predicting risk across the network irrespective of crash history. Despite data accuracy limitations, a full set of Indonesian vehicle SPFs and pedestrian crash rates was developed using data from 70% of the road network and validated on the remaining 30%. For vehicle (non-pedestrian) mid-block locations, 21 SPFs were developed; most use traffic flow, segment length, and a provincial factor to estimate crash risk. A broader set of pedestrian crash rates was also developed, with validation performance generally acceptable. The models were then used to create crash-risk maps that communicate risk at province, region, and national levels and remove the need for practitioners to manually apply individual models to estimate segment-level risk. These maps will help the Indonesian highway authorities identify and target high-risk locations and routes for safety improvement.

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Developing methodologies for road safety performance indicators: lessons from Trendline

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Abstract

The European Trendline programme developed methodologies for ten new road safety performance indicators (SPIs) addressing critical monitoring gaps in areas such as drug driving, urban speed management, micromobility, traffic rule compliance, and enforcement. A central requirement was cross-national comparability within the European Union (EU). This Extended Abstract reports on methodological obstacles encountered and approaches adopted to overcome them, focusing on three overarching dilemmas: the tension between simplicity and accuracy, the balance between objectivity and feasibility, and achieving cross-national comparability under diverse legal and cultural frameworks. While specific challenges arose for each SPI, recurring solutions included tiered methodological options, minimum core requirements combined with national flexibility, and triangulation of observational and self-report data. The lessons learned provide a roadmap for future harmonised SPI development and support the EU's ambition of evidence-based road safety policy. The Trendline experience is equally relevant to road safety monitoring in Australasia, where similar cross-jurisdictional harmonisation challenges apply.

Introduction

The European Union (EU) has set ambitious road safety targets, aiming to halve fatalities and serious injuries between 2020 and 2030 and to approach zero road deaths by 2050. Progress towards these targets requires not only outcome indicators such as fatalities and serious injuries, but also intermediate road safety performance indicators that capture the risk factors which influence crashes (Van den Berghe et al., 2024). These SPIs, called KPIs (Key Performance Indicators) in the EU, can serve as evidence-based tools for policy makers, enabling governments to identify problem areas, monitor effectiveness of interventions, and benchmark performance against other jurisdictions.

The Baseline programme (2020-2022) was the first large-scale European effort to harmonise SPI data collection and analysis across Member States for eight standard indicators covering areas such as speeding, drink driving, seatbelt use, and helmet wearing. Building on this foundation, the Trendline programme was implemented from 2023 to 2025; it extended the scope of road safety monitoring by developing new experimental indicators in areas not yet systematically covered in European countries. The selection of these new indicators followed a structured and transparent process, starting from a longlist of approximately 30 candidate indicators that was finally reduced to a final set of ten, by applying criteria such as national policy relevance, expected feasibility, and likely international comparability (Van den Berghe & Stelling, 2025). These indicators are listed in Table 1.

Table 1. The ten new experimental SPIs in the Trendline programme

1. Driving under the influence of drugs 2. Share of 30 km/h roads in urban zones 3. Compliance at signalised pedestrian crossings and intersections 4. Compliance at unsignalised pedestrian crossings and intersections 5. Helmet use by Personal Mobility Device (PMD) riders	6. Self-reported risky behaviour 7. Attitudes towards road safety 8. Light use by cyclists in the dark 9. Enforcement of traffic regulations 10. Alternative speeding indicators

This paper focuses on the cross-cutting methodological obstacles encountered in developing these KPIs at an international level, and the solutions adopted.

Method

For each indicator, an expert group was established, bringing together specialists from multiple EU Member States to draft methodological guidelines, oversee pilot studies, and review results. The methodological development for each new indicator followed a sequence of iterative steps: 1) literature review and expert consultation; 2) draft of initial methodological options; 3) a small-scale pilot in one Member State; 4) revision of guidelines based on pilot feedback; and 5) further pilots in additional Member States. This iterative process allowed both scientific robustness and practical feasibility to be tested before methodologies were finalised.

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Cross-national comparability was a primary design criterion throughout. This required ensuring similarity of procedures and producing indicator values that are meaningful when placed side by side across countries with different legal frameworks, national databases, enforcement practices, and cultural attitudes towards road safety. Where complete harmonisation was impossible, the approach was to ensure minimum transparency requirements so that the conditions under which each country's data were collected are clearly documented.

Results

KPI-specific methodological challenges

Drug driving (Kint et al., 2025). This SPI faced the most severe legal obstacles. Random roadside saliva testing is the most accurate method for detecting drug impairment, but its legality and police feasibility differ widely across Europe. Three methodological tiers were therefore defined: 1) a gold standard using police-supported roadside saliva testing; 2) researcher-led testing at service stations; and 3) self-reported surveys as a minimum standard. Each tier constitutes a distinct method, ensuring within-method but not across-method comparability.

Share of 30 km/h roads (Weijermars et al., 2025). The basic SPI definition for 30 km/h streets was chosen as the share of urban road length with a 30 km/h or lower speed limit. This definition was selected for its simplicity and policy relevance. However, it does not account for physical separation infrastructure on roads with higher speed limits, nor for actual travel speeds rather than posted limits; hence more advanced and complex definitions were piloted as well. A simplified definition was the share of cities with a generalised 30 km/h limit.

Compliance at crossings and intersections (Ambros et al., 2025). Challenges for defining an SPI on traffic rule compliance at crossings included the low prevalence of violations making sample size requirements large, the absence of a common typology of crossing designs across countries, and substantial variability in behaviour by time of day and region. Despite these difficulties, a validation exercise confirmed a statistical relationship between violation rates and casualty rates, supporting the indicator's representativeness.

PMD helmet use (Kšicová et al., 2025). The rapid growth of e-bikes, e-scooters and other personal mobility devices created demand for a SPI on protective equipment. Key challenges included the absence of standardised PMD categories across countries and the very low helmet wearing rates observed in pilots. Compulsory helmet legislation was absent in most participating countries. Solutions included the development of a clear taxonomy of PMDs and standardised observational protocols, supplemented by optional automated camera-based methods.

Self-reported behaviour and attitudes (Silverans & Meesmann, 2025). Self-report surveys are cost-effective but are prone to social desirability bias and recall error. Drawing on experience from the ESRA and SARTRE surveys, Trendline supported period-based self-reports (e.g., behaviours in the last 30 days) to improve recall accuracy. Harmonised survey items and weighting procedures were applied to reduce cross-cultural response biases. Attitudinal items were included alongside behavioural self-reports to enable triangulation.

Cyclist light use in the dark (Moreau et al., 2025). Challenges centred on an operational definition of darkness, selecting representative observation sites, and reliable identification of lights on moving cyclists. Darkness was defined as natural light levels below 26 lux. Observations distinguished between fully visible, partially visible, and non-visible lights. Camera-based automated detection was explored to complement roadside surveys.

Enforcement of traffic regulations (Laiou et al., 2025a). Enforcement data vary enormously across Member States. A single harmonised definition was infeasible. Instead, a menu of equivalent options was defined such as the number of police controls per capita, the number of tickets issued, and the number of automated cameras per road length. Countries should select the most applicable measure while documenting their choice.

Alternative speeding indicators (Laiou et al., 2025b). The established speed SPIs typically measure the proportion of vehicles within the speed limit, but this masks the severity and distribution of speeding behaviour. Trendline introduced complementary indicators measuring the share of vehicles exceeding the limit by more than 10, 20, or 30 km/h, alongside speed variance measures.

Three cross-cutting dilemmas emerged across multiple SPIs:

(1) **Simplicity vs. accuracy**: The basic 30 km/h share indicator and alternative speeding thresholds are straightforward and policy-relevant, but miss nuance. Solution: a minimum simple definition with optional refined variants.
(2) **Objectivity vs. feasibility**: Observation-based indicators (PMD helmets, cyclist lights) are objective but resource-intensive. Self-reports are scalable but biased. Solution: minimum observational requirements plus validated self-reports as complementary tools, with triangulation where possible.
(3) **Cross-national comparability vs. national flexibility**: Rigid common definitions were often legally or operationally infeasible. Solution: menu-based approaches with mandatory transparency on chosen method.

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Discussion

The overarching lesson from Trendline is that methodological development of road safety SPIs is as much a process of negotiation and consensus-building as it is of scientific design. The involvement of multi-national SPI expert groups proved crucial. Diverse perspectives ensured that proposed methodologies were scientifically robust and also politically and practically feasible across very different national contexts.
A consistent finding was the importance of defining clear and standardised exposure measures. Whether measuring speed, infrastructure coverage, or behavioural compliance, the definition of the exposure variable (road length, number of interactions, distance travelled, etc) significantly affects SPI values and their interpretation. A country may show a high share of 30 km/h roads, but if these are lightly travelled residential streets, the road safety impact may be modest.

SPI methodology development must be seen as an ongoing process rather than a one-time exercise. As new mobility modes emerge (e.g., autonomous vehicles, e-scooters), technology evolves (e.g., automated detection), and data availability improves, indicators must be periodically reassessed. Trendline's experience demonstrates that continuous methodological innovation can be achieved through structured international collaboration.

For Australasian practitioners, the Trendline experience offers several transferable insights. Defining a gold standard alongside simpler but acceptable alternatives is directly applicable to jurisdictions where operational capacity or legislative frameworks differ. The emphasis on transparency, documenting the method used rather than enforcing uniformity, ensures that data users can properly interpret and compare indicator values. Finally, the iterative development cycle, moving between expert groups, piloting, and revision, provides a model for developing new harmonised indicators in the Australasian context.

Conclusions

The Trendline programme has demonstrated that it is possible to develop credible, policy-relevant SPIs in complex and evolving domains of road safety. While the legal, practical and conceptual obstacles were considerable, the iterative process yielded methodologies that are both scientifically defensible and implementable across diverse national contexts. Some indicators, such as alternative speeding and self-reported risky behaviour, are ready for large-scale implementation. Others, such as drug driving and PMD helmet use, require further refinement as legal frameworks and technology evolve.

The broader lesson is that developing harmonised road safety SPIs requires principled compromise: minimum methodological requirements must be set to ensure comparability, while allowing flexibility for national circumstances. These lessons translate directly to the Australian and New Zealand road safety context. Developing common SPIs across jurisdictions is complex but achievable, provided the process is iterative, inclusive of diverse expertise, and transparent. The evidence base developed through Trendline can directly inform efforts to strengthen harmonised road safety performance monitoring in the Australasian region, supporting the translation of evidence into safer roads.

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Road policing targets: Are we missing the mark?

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Abstract
Some have argued that quantitative traffic enforcement targets can motivate or incentivise increased road policing activity, others have shown that policing targets can instead lead to perverse incentives and behaviour. Particularly so when targets are challenging, detaching the desired activity from the intended outcome. Increases in traffic enforcement outputs (speeding offence detection and breath screening tests) accompanied the introduction of the targets in New Zealand, however, this was also the case in the 18 months prior. Evidence of perverse behaviour was detected in late 2025 in the form of falsified breath tests and unusual speed offence detection. The current paper reviews the use of policing targets and their unintended consequences. An alternative performance management approach is proposed.

Background
In 2024, New Zealand Police assigned several national quantitative targets for speed limit exceedance offence detection and the number of alcohol breath screening tests taken. The targets were set quarterly and carried a financial penalty if not met. The intended goal of these targets was to increase or maintain high levels of traffic enforcement activity to improve road safety. As pressure to deliver against targets mounted at both a national and district level, questions about the efficacy of using output-based policing targets to sustainably manage performance objectives emerged.

Conference theme
The current paper describes a confronting scenario where the desired intent of using police targets to achieve increases in traffic enforcement intensity collided with evidence on the negative effects of apportioning national and police district-based quantitative output targets for speeding offence notices and breath alcohol screening tests.

From both existing literature and other international experience, it was expected to find examples of perverse incentives driving behaviour that runs contrary to the intended outcome (improving road safety performance) when the measure (traffic enforcement offence detection and breath testing numbers) also becomes the target. This issue is explored in the context of recent developments in New Zealand, where evidence of perverse behaviour was discovered upon the introduction of (increased) traffic enforcement output targets.

An alternative performance and outcomes framework is proposed, where inputs (police activities) are connected to intermediate outcomes (behaviours and community perceptions) and final outcomes (traffic casualty rates) to deliver a more effective and sustainable road policing model to improving road safety performance.

Project description
In late-2025, New Zealand Police sought to undertake an evidence-based allocation of district-level targets to achieve on the national road policing targets, such as the number of breath tests, drug tests, and speeding offence notices. The project was initiated with a systematic literature search to determine the evidence base for such an exercise. The findings of this search largely did not support the intended goal which suggested forms of perverse behaviour would result. This was investigated and led to the discovery of anomalies in police-recorded data.

Findings

The ‘Goodhart effect’
Economist Charles Goodhart observed that once a metric or proxy is used as an incentive for performance, people will find ways to ‘game’ the given metric, thereby destroying its value. This phenomenon has been described as ‘Goodhart’s Law’, which states: “When a measure becomes a target, it ceases to be a good measure”.

Goodhart’s law predicts that upon introducing a target (or quota) which acts a proxy for an outcome, people will naturally find a way to deliver on the targeted proxy by ‘gaming the system’ even if doing so runs against the intended outcome. In other words, this law expects that any observed statistical regularity will tend to collapse once pressure is placed upon it for control purposes. I.e. the measurement of the performance of a given property of a system becomes problematic once it also becomes the target (a perverse incentive is introduced).

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This phenomenon is also colloquially known as the Cobra Effect. This describes a hypothetical initiative whereby a reward for dead cobras was paid in attempt to curb the cobra population due to public safety concerns. In response, the local population purportedly started to breed cobras in 'cobra farms', resulting in more cobras compared to before the said initiative.

Policing by targets

Some have argued that the introduction of targets or traffic citation quotas can be leveraged to motivate increased road policing activity and engagement (Yasanthi et al., 2024). However, others have found it leads to a loss of intrinsic motivation and moreover reported on various examples of the Goodhart effect producing unintended perverse behaviours when a metric was introduced as a police target. This includes:

- Selection or cream skimming: choosing easy tasks rather than important ones
- Manipulation: changing how data is collected or categorised
- Myopia: ignoring long term goals or outcomes for short term targets
- Forms of over-policing: focussing on low risk offences in certain neighbourhoods (Ossei-Owusu, 2021)

International examples from previous studies detail instances of policing targets leading to unintended (perverse) outcomes. This includes downgrading the severity of recorded crime and making it onerous for victims to report a crime (Eterno & Silverman, 2017; Schenker, 2023), unlawful stops and searches to report activity (Bronstein, 2015), targeting low level traffic offences that are easy to resolve and ignoring high risk offending such as DUI due to processing time (Edwards & Rushin, 2024), investigating only cases that are easy to clear and overcharging in order to increase the resolution rate (Gorby, 2013; Sparrow, 2015). Victoria, Western Australia, and the Republic of Ireland have each reported issues relating to the falsification of breath tests upon introducing or increasing numerical targets for preliminary breath tests (Comrie, 2018).

To assess whether the introduction of road policing targets in New Zealand, alcohol testing and speed offence detection was analysed for anomalous records. An interrogation of Police recorded breath testing data using device ID, test timestamp and GPS location, revealed several series of tests in 2024/25 that would be impossible to perform without manipulation; these were performed within short succession while travelling at speed. For example, a series of 11 tests using one device where the average time between tests was <30 seconds apart, over a 3.5 km distance (i.e. the testing was being conducted in quick succession while in motion).

Approximately 30,000 tests were found to have been probably falsified, though the full extent of this issue is impossible to determine. In addition to finding evidence of perverse incentives leading to falsified breath tests, other examples of road policing targets were also found to be potentially associated with unintended outcomes (Table 1). While the scale of the unintended outcome being motivated currently may be relatively minor, this can grow in scale if left unchecked (Ossei-Owusu, 2021).

Table 1. Examples of road policing targets and corresponding unintended outcome.

Strategic goal	Police target	Risk of Goodhart effect
Reduce speeding	Number of speeding tickets	Speed enforcement conducted in locations where offence detection is most efficient
	Number of speeding notices on roads with speed limits >80 km/h (proxy for 'rural roads')	Deployment to safer roads with higher traffic volumes and motorways
	Proportion of speeding notices <11 km/h excess	Discounting of speed notices (peaks and valleys in the notice distribution by amount exceeded)
Deter drink driving	Number of breath tests	Falsifying breath tests
	Number of tests during high alcohol hours	Avoiding low volume roads where EBAs are more likely

An inputs-outcomes framework

In light of the findings in the present paper, it is recommended that policing services consider alternatives to a output target-based model. While it may seem counterintuitive, the counting of outputs (e.g. notice numbers) can still be a useful measure and it is used to compare and contrast jurisdictions and enforcement intensity over time (Carson et al., 2022). The problematic aspect of using the proxy (traffic enforcement outputs) as a target for the outcome (reducing risky traffic offences / improving road safety performance) is that the connection between the inputs and the desired outcomes is lost; the focus shifts on delivering the outputs by whichever means.

Another way of designing a performance framework may seek to inspire motivation to increase enforcement intensity by focussing on the road safety outcomes and connecting it to high quality prevention policing and enforcement at all

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levels of the policing service. It is envisioned that better connecting the daily prevention activities of road policing staff to the desired outcomes will lead to a motivated road policing service and innovative solutions to improving road safety, rather than just focussing on ticket or test counts.

Table 2. Inputs outcomes framework for speed enforcement and alcohol testing.

Inputs	Outputs	Intermediate outcomes	Outcomes
Number of checkpoints	Number of passive breath tests conducted	Percentage of drivers >0 BAC and above applicable limits Community perceptions of CBT checkpoints	Number of DSIs involving alcohol Number of all crashes involving alcohol
Proportion in high alcohol risk times	Number of breath tests at high alcohol hours		
Use of intelligence and tactics to apprehend repeat and high end offenders	Repeat and high end alcohol offenders apprehended (link to alcolock)		
Rural deployment for speeding Geocoded dispersion of speed detection	Number of speed offences	Mean speed Percentage of traffic travelling within speed limits Community perceptions of speed enforcement	Deaths per billion VKT deaths Serious injuries per billion VKT
	Number of officer issued speed offences under 11km/h over the speed limit		
	Proportion of geocoded speed enforcement data in rural zones (LINZ definition).		

Benefits to road safety

The current paper presents a cautionary tale regarding the use of output targets for road policing, which may harm the intended outcome of improving road safety in the long term. An effective, intrinsically motivated road policing service is a key component of a safe system approach to road safety.

Implications for policy and/or practice

Care should be taken when designing and implementing a performance measurement framework for road policing services. It may be tempting to seek increases in policing activities by allocating targets, however, in the longer term these targets could come at the cost of perverse incentives and the erosion of motivation.

Conclusions

It can be demonstrated from existing evidence that higher intensity traffic enforcement is effective in reducing the rate of road trauma, it is not necessarily also true that an output based objectives method is the best, only, or a sustainable means of getting there. Forms of perverse behaviour or attempts at 'gaming the system' can be expected when a measure of police activity also becomes the target. This has been found internationally in various policing settings and has now also been found in various forms in New Zealand. It is proposed that a framework which more strongly emphasises the connection between inputs to the intermediate and final road safety outcomes may be more conducive means to a sustainable high performing road policing service.

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DRAFT

AI-driven insights support Safe System decision-making at rural intersection

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Abstract
ROSIICAM (Road Safety Incident Investigation Camera) uses artificial intelligence (AI) and video analytics to capture road safety insights and support proactive risk assessment. In July 2025, ROSIICAM was deployed at a rural link intersection, following a sudden increase in serious injury crashes after changes to the intersection layout. Over a four-week period the system detected 2 crashes, 14 near-misses, and 68 instances of confusion on priority involving right-in and left-in turning vehicles, indicating general driver uncertainty at the existing layout. The Valla Beach findings illustrate ROSIICAM's value in providing objective evidence of behaviour-based safety issues that are not reflected in crash data alone. Insights from this deployment helped support a roundabout design to support safer access for the community.

Background
ROSIICAM is a Transport for NSW road safety investigation program that uses portable cameras and artificial intelligence to automatically detect crashes, near-miss events and unsafe road user interactions. The system captures short, deidentified video clips and associated operational data, including vehicle speeds, movements, volumes and road user types. ROSIICAM is not an enforcement tool and does not record personal or vehicle identification information. Its primary purpose is to provide proactive, behaviour-based evidence to support safety assessment and decision-making. Since 2022, cameras have been installed at 29 sites across NSW, including busy urban locations, roundabouts, and highways, with the cooperation of multiple suppliers.

The intersection of Giinagay Way and Valla Beach Road, Valla operates as a peri-urban rural link road and is the only access point for ingress and egress for the local community of about 800 residents. Residents raised concerns regarding the safety of this intersection. In 2015 there was a double crash resulting in two fatalities at the intersection, when a light rigid vehicle turning right out of Valla Beach Road onto Giinagay Way collided with an emergency services vehicle under lights and sirens headed southbound on Giinagay Way. This resulted in the left turning lane being slightly offset to increase sight distance in 2016.

The intersection of Giinagay Way and Valla Beach Road experienced a sudden increase in serious injury crashes following changes to traffic conditions and intersection layout. These changes included a permanent reduction of the speed limit to 60 km/h, additional give way line marking and signage on the south bound left turning lane on Giinagay Way, traffic separators and enhanced signage. A Safe System Review identified several persistent contributors to the risk: dominant right-through-through crash movements; speed limit non-compliance; restricted sight distance; and driver confusion associated with the non-standard left-turn slip lane and offset priority.

Figure 1: Aerial view of the intersection of Giinagay Way and Valla Beach Road, April 2025
Source: Nearmaps

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Conference theme
This work used evidence gathered through video analytics to quantify risk and inform infrastructure planning and design.

Project description
ROSIICAM collected video footage at the intersection of Giinagay Way and Valla Beach Road for a four-week period between 2 July 2025 to 2 August 2025. Information that could be used to identify road users such as faces and number plates were automatically blurred to protect privacy.

The system detected and classified:

- Traffic counts for all vehicle classes.
- Crashes and near-miss events using Post Encroachment Time (PET) as the primary surrogate safety measure. PET is the time difference between two vehicles occupying the same space.
- Confusion events, where left-turn-in and right-turn-in vehicles both give way.
- Incorrect Give Way events, where right-turn-in vehicles incorrectly give way to left-turn-in vehicles.
- Non-compliance events, where left-turn-in vehicles fail to give way to right-turn-in vehicles.

Findings

Conflict Events and Near Misses
In total, ROSIICAM analysis found:

- 2 crashes
- 14 critical conflicts/near-hits
- 68 instances of confusion on who has right-of-way.

Around 96% of events involved a light vehicle. Other road users including buses, a heavy vehicle, a motorcycle and a bicycle were also involved in events. Both crashes involved a light vehicle, and one involved a utility vehicle, the other a heavy vehicle. Events were spread throughout the days of the week with a higher number of events in the afternoon.

Both crashes were opposing direction right-through crashes. In both cases, review of the videos shows the motorist turning right into Valla Beach Road appears to be concentrating on a vehicle in the left turning lane approaching the give way line, taking focus away from the oncoming through traffic, resulting in a right-through crash.

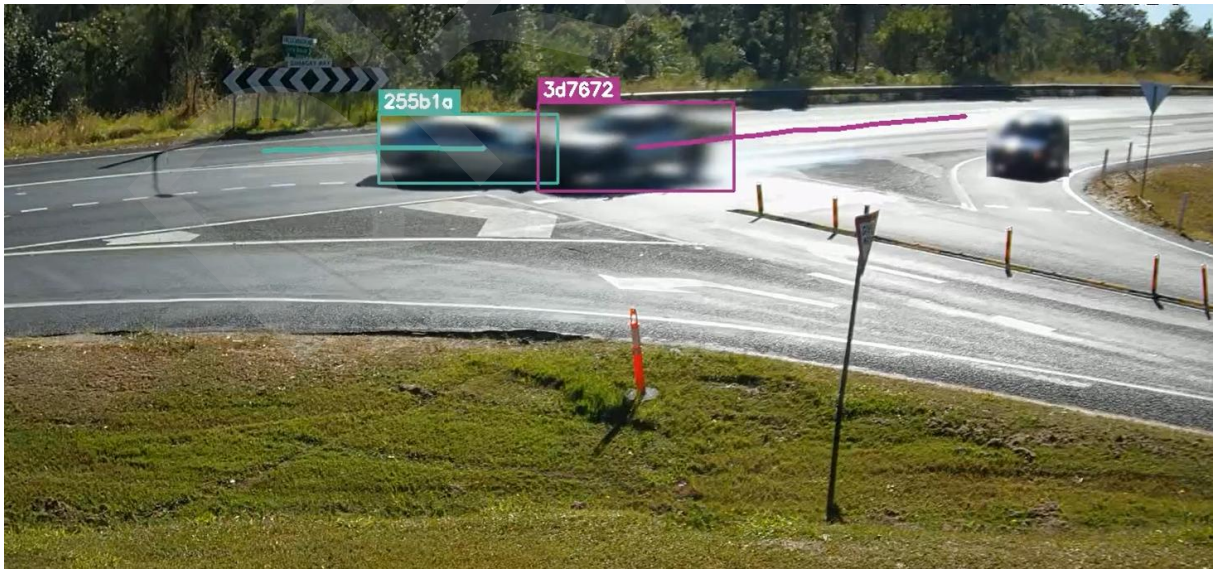

Figure 2: A crash event detected by ROSIICAM.
Source: Transport for NSW

During a Safe System Review site inspection conducted in June 2025, Transport for NSW practitioners observed multiple motorists appearing to focus on who had priority instead of looking at oncoming traffic when completing the right turn movement. These findings were confirmed by ROSIICAM data which showed that the majority of detected events involved opposing-direction right-through conflicts. This was consistent with the primary risks identified through historical crash analysis and site inspection.

Speeds

Speed data collected by ROSIICAM shows the 85th percentile speed was 70km/h. The mean speed was 59km/h. This indicates that speed non-compliance was a contributing factor at this location.

Speed data associated with detected events showed vehicles operating above the posted 60 km/h limit on 4 occasions (of the 84 detected events). In one of the crash events, the through vehicle was travelling at 71km/h. This confirmed that speed limit non-compliance persisted and contributed to elevated conflict severity, supporting assumptions made during the Safe System Review.

Intersection treatment

The objective evidence provided by ROSIICAM coupled with the outcomes of the Safe System Review supported a decision to install a roundabout at the site. It was constructed in January 2026. A roundabout directly addresses the main risks identified at the site by removing confusion on who has right of way, reducing approach speeds, and reducing the angle of crashes to minimise crash severity. Road narrowing works were also undertaken to support reducing operating speeds.

Figure 3: Photographs of the roundabout and other intersection treatments
Source: Transport for NSW

Benefits to road safety

These findings helped to inform Transport for NSW's progression of a roundabout design as the optimal treatment. The roundabout simplifies turning movements, controls approach speeds and substantially reduces the likelihood and severity of future crashes.

Implications for policy and/or practice

This case study demonstrates how AI-driven insights can complement traditional road safety analysis. ROSIICAM identified high-risk interactions not evident from crash data and quantified anecdotal evidence observed at site inspections and received from the community. This facilitates proactive treatment rather than waiting for further severe outcomes.

Conclusions

ROSIICAM proved to be a valuable tool for validating and quantifying risk at an intersection on a per-urban rural link road. By capturing near-miss events, operational speeds and conflict behaviours, the system strengthened the evidence base for decision-making and supported the construction of a roundabout at the site. It is proposed to re-deploy ROSIICAM in the near future to capture current road user behaviour and complete a pre-and post- treatment assessment. The findings highlight the potential for this technology to play an important role in Safe System implementation across regional road networks.

Beyond the dashboard: using telematics to measure road safety performance

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Abstract
In NSW, almost 30 per cent of workplace fatalities result from road crashes. There is growing interest in telematics to support safe driving and fleet management initiatives. This paper examines key considerations for using telematics data to assess workplace road safety performance, drawing on learnings from a large light vehicle fleet project. Data accuracy emerged as a central challenge: manual validation of speeding events revealed discrepancies between commercial mapping speed limit data and the official NSW government database. Learnings highlight the need for rate-based metrics, such as events per 100 km or per active driver, to enable meaningful comparisons across teams. It also found that commercial platforms are not equipped to manage the data volumes associated with large fleets, and that safety scorecards require careful interpretation. To address these challenges, a custom dashboard was developed to provide reliable, actionable reporting for executives monitoring fleet safety.

Introduction
In New South Wales almost 30 per cent of workplace fatalities are a result of road crashes at work, while about 25 per cent of the state's road toll involves a vehicle being used for business (Transport for NSW, 2025). The majority of these involve a car or light truck.

Vehicle telematics devices are being increasingly adopted by employers as a risk control measure to support organisational safe driving and fleet management initiatives. Telematics refers to the use of a device in a vehicle to record data on speed, location, acceleration. These devices use sensors including accelerometers, gyroscopes, Global Navigation Satellite System (GNSS) coordinates and can even access integrated vehicle sensors such as Controller Area Network (CAN) vehicle speed, engine rpm and fuel use to monitor and send this information back to a central database/repository.

This paper examines key considerations for using telematics data to measure workplace road safety performance, drawing on findings from a large light-vehicle fleet project.

Conference theme
This work reflects the theme From Evidence to Action: Shaping a Brighter Future because crashes involving a vehicle being used for work are a significant part of the road toll. Telematics devices provide rich data that could help identify risky driving behaviours in workplace vehicles. But how can we turn this data into useful information that can lead to behaviour change? This paper examines key considerations for turning telematics evidence into actionable road safety insights, drawing on learnings from the development of a custom dashboard for a large light vehicle fleet.

Project description
A large workplace fleet consisting of over 1600 light vehicles was fitted with telematics devices. Most installations took place between June 2023 and June 2024. The stated organisational aims of the telematics deployment were twofold - to improve vehicle management and to monitor driver behaviour. The telematics devices collected onboard sensor data. This included data points position, speed, heading/trajectory, acceleration and rotation. Vehicle CAN data (vehicle speed as captured by the vehicle speedometer and vehicle rpm as captured by the tachometer) was not collected in this project.

The telematics device consisted of two parts: a screen interface fitted to the dashboard and the telematics recorder which was not visible to drivers. Before starting a trip, drivers were instructed to log in to the device using their employee number and to enter their trip purpose. No further interaction with the screen was required at any stage of the journey, and no speed warnings were provided by the telematics device. It is possible that some of the vehicles issued speed limit warnings through the vehicles' Advanced Driver Assistance Systems (ADAS).

Data was transmitted via mobile networks to the commercial telematics provider and accessed by an Application Programming Interface (API) interface. The organisation developed a dashboard to allow managers to monitor safety events of drivers under their supervision, and to help them manage the usage of vehicles in their custody.

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Separate to the operational dashboard, this paper's project team developed a custom executive dashboard. The purpose of the dashboard was to equip organisational leaders with data to track road safety performance over time, enable benchmarking, support executive oversight of team outcomes, and identify high risk areas to inform strategic safety initiatives. A separate 'view' which contained only anonymised data to protect driver privacy was created solely for the purposes of this executive dashboard.

Findings

Reporting on safety metrics

Most, if not all, commercial telematics providers have their own software platforms that users can use to view the driving data of their fleet. For the light vehicle fleet in this project, some challenges were found with using this platform:

- The platform was not equipped to manage the data volumes associated with a large fleet of over 1600 vehicles. It was not possible to extract a report for more than 700 vehicles at a time.
- The platform did not easily allow for separating the fleet into sub-teams to compare road safety performance across teams within the organisation. Managers would have been able to view records of staff outside their direct reporting line, creating privacy risks.
- Safety events are reported in absolute numbers, with no consideration of the size of the team or the distance driven.

To address these challenges, a custom executive dashboard was developed. This dashboard focused solely on reporting road safety performance at a high-level to leaders of the organisation. It was not a tool for the day-to-day management of vehicles or monitoring individual drivers. The purpose of the dashboard was to help identify high risk areas to inform strategic safety initiatives.

The project team adopted a rate-based approach to reporting. This allows for meaningful comparison across teams of varying risk exposure. The rate of events per 100km per travelled and the rate of events per active driver were the main calculated metrics used.

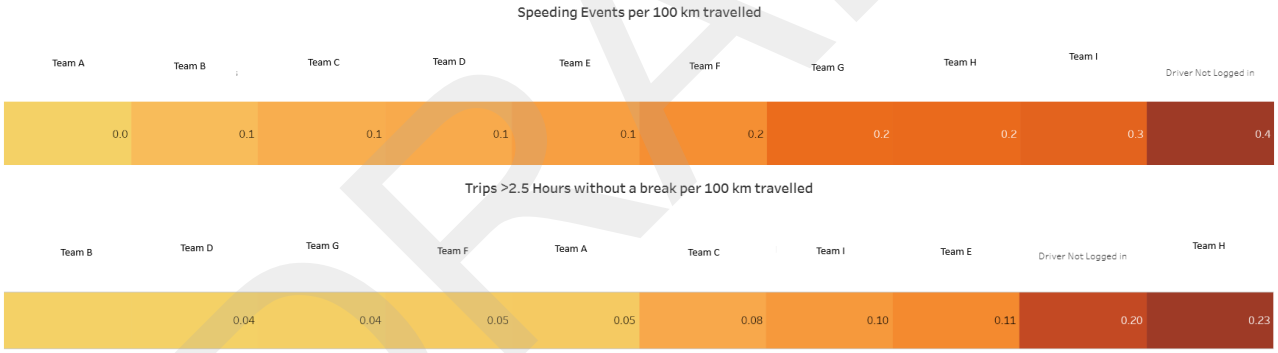

Figure 1. Snapshot of the Safety with Fleet Telematics Dashboard showing the rate of safety events per team

The project identified challenges with driver login compliance, with approximately 35% of trips over a 6-month period having missing or incorrect driver identification, limiting the ability to accurately attribute safety events.

Driving scorecards

Some commercial platforms provide a calculated 'driving score' or 'safety score'. This score is derived with many measurements/formulas being used to arrive at a score, with weightings given to different metrics. There appears to be little consensus across providers on what should go into a driving score and the weighting assignment. Data points and weightings chosen are highly dependent on workplace goals. This project found that some commercial scorecards include metrics in the driving score that are not relevant to safety. For example, idle time. Idle time measures the length of time that a vehicle has the engine running but is not moving. Vehicles with a long period are scored unfavourably. Idle time is relevant to fuel efficiency and vehicle usage but not road safety. A longer period of idle time could in fact be a positive as it may indicate that the driver is resting and breaking their journey to manage fatigue risk. Careful interpretation of driving scores and the metrics used to calculate those scores is advised before using these to assess safety performance. Some platforms allow the user to customise the metrics that are included in the scorecard.

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Data accuracy and safety events

Speeding events were defined by the organisation as follows:
(a) > 30km/h over speed limit
(b) > 130km/h
(c) > 10% over the posted speed limit for duration of 30 seconds

These thresholds were chosen to minimise the potential for reporting erroneous speeding events. To determine a speeding event has taken place, the telematics platform takes the GNSS-determined location and speed from the telematics device and matches these against the location's speed zone taken from a commercial speed zone dataset.

The project team undertook an analysis to verify the accuracy of speeding events. All speeding events for the month of February 2025 were used. The speed zone value for each event's location was compared against the value in the NSW government speed zone dataset for the same location, using latitude and longitude coordinates. The NSW government speed zone dataset is maintained by Transport for NSW. Of 71,510 speeding events,

- 51,135 events (71.5%) matched, i.e. the speed zone value was the same in both datasets.
- 20,375 events (28.5%) could not be matched, i.e. the speed zone values differed in each dataset, or the event occurred on a private road or outside of NSW.

The project team was unable to verify which of the two datasets was correct in instances where the values did not match. For the events where the speed limit data aligns, there is a greater likelihood that these are true speeding events. These discrepancies demonstrate the need for mechanisms to detect and correct erroneous events to maintain user trust.

Benefits to road safety

25% of the NSW road toll involves a vehicle being used for business. The use of telematics data that takes into consideration data accuracy, governance, and robust reporting will help workplaces better understand their road safety risks and develop strategies to address those risks.

Implications for policy and practice

Employers have a primary duty of care to provide and supervise a safe system of work. (Work Health and Safety Act NSW, 2011). A vehicle is considered a workplace. Telematics, if deployed correctly, can help workplaces manage this risk more effectively. Organisational policy should require that telematics derived safety events, especially speeding, be crosschecked against authoritative datasets and that reporting frameworks use rate-based benchmarking--checked against authoritative datasets.

Conclusions

Telematics data can meaningfully enhance workplace road safety when supported by accurate data and carefully designed reporting support tools. These learnings highlight the importance of well-designed tools that enable organisations to better identify road safety risks in the workplace, support behaviour change, and ultimately reduce road crash trauma.

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The Missing Pillar: strengthening post-crash response in Australia

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Abstract
Post-crash emergency response remains one of the least developed components of Australia's Safe System—an evidence gap that directly threatens progress toward the 2030 trauma-reduction targets. Drawing on global evidence, national strategy reviews, and emerging operational practice in NSW, this work identifies the actions required to translate post-crash evidence into system-wide improvements. The review and collaboration processes have highlighted five post-crash measures that could help improve results for those injured 1) Introduction of automatic crash notification, 2) Training of bystanders to improve information collection and dissemination to emergency services, 3) Introduction of rapid extraction and rescue techniques for first responders, 4) Expansion in the use of medications on scene by first responders and 5) Improvement in the collection of data on response, extrication and transport to definitive care.

Introduction
While crash prevention remains the primary road-safety priority, post-crash emergency response continues to be an overlooked Safe System element, with limited strategic focus on retrieval, prehospital care and trauma outcomes across Australia. Research dating back to 2013–2014 noted the absence of meaningful performance measures and highlighted the need for trauma-informed post-crash policy development. While the World Health Organization identifies post-crash response as a core pillar of global road safety, a review of the National Road Safety Strategy 2021–2030 and major Australian state strategies shows that most have not adopted it as a standalone pillar.

Conference Theme — Evidence to Action
This work reflects the theme *From Evidence to Action: Shaping a Brighter Future* by demonstrating how evidence-based advancements in extrication from a crash, trauma care and psychosocial support for victims and first responders, can be translated into practical improvements that strengthen the Safe System and reduce the burden on the communities we serve.

Project Description
This abstract uses a structured narrative review supported by targeted policy comparison and practitioner collaboration. The methodology comprised five steps: (1) review of earlier Australasian publications that identified gaps in post-crash treatment and trauma system performance; (2) review of the National Road Safety Strategy 2021–2030 and relevant state and territory road safety strategies and action plans; (3) comparison of the extent to which each jurisdiction explicitly recognised post-crash response within its strategic architecture; (4) consideration of recent policy and operational developments in Western Australia and New South Wales; and (5) incorporation of insights from collaboration with the UK IMPACT Centre and the EXIT Project. Jurisdictions were assessed against common criteria, including whether post-crash response was identified as a pillar, objective, action area or measurable program focus; whether specific actions addressed notification, rescue, prehospital care, transport to definitive care or psychosocial recovery; and whether performance measures or implementation responsibilities were evident.

Findings
The review found that post-crash response remains insufficiently embedded in most Australian road safety strategies. Evidence from the strategy review indicates that, in most jurisdictions, post-crash measures are either absent, dispersed across broader trauma or emergency management activities, or not framed as a distinct Safe System function. Western Australia stands apart because its strategy and action plan more clearly acknowledge post-crash activity and provide a stronger foundation for implementation. New South Wales has only recently begun operationalising post-crash measures through emerging policy and practice attention, but these measures are not yet comprehensively embedded in strategic performance frameworks.

Based on the evidence review, comparative jurisdictional analysis and collaboration with subject matter experts, the following measures are recommended to strengthen post-crash response and improve immediate and longer-term outcomes for casualties, bystanders, first responders, and families affected by road trauma:

1. Introduction of automatic crash notification in new vehicles and supporting infrastructure and systems for response.

2. Training bystanders to improve initial information provided to emergency services as well as immediate assistance to vehicle occupants.
3. Introduction of rapid extraction and rescue techniques based on evidence from clinical studies in the United Kingdom.
4. Expansion in the use of medications on scene by first responders to reduce blood loss from non-compressible bleeding.
5. Improvement in the collection of data pertaining to initial response times of emergency services, extraction duration and arrival time at definitive care.

Benefits to Road Safety

Strengthening post-crash response offers improved survival outcomes; enhanced trauma system performance; better psychosocial outcomes; a more complete and modern Safe System.

Implications for Policy and Practice

There is a strong opportunity for NSW to formally embed post-crash response within its 2031 Road Safety Action Plan and for other jurisdictions to do the same in future strategies and implementation plans. A practical pathway would involve five linked steps: first, explicitly recognising post-crash response as a distinct component of the Safe System within strategic documents; second, assigning lead agency responsibility across road safety, health, ambulance, police and fire and rescue sectors; third, piloting priority interventions such as automatic crash notification, updated rescue practices and enhanced trauma care protocols; fourth, developing shared data collection and reporting arrangements; and fifth, evaluating outcomes and scaling successful measures.

Conclusions

Post-crash response remains the missing pillar in most Australian road safety strategies. Its inclusion presents an opportunity to improve crash outcomes.

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DRAFT

Applying rail sector safety and reliability metrics to road operations

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Abstract
Long established evidence from the rail sector shows how transparent, passenger-centred performance frameworks can strengthen safety and reliability. Metrics such as comprehensive HSE indicators, on time running and cancellation rates provide proven ways to monitor system risk and support operational resilience. Managed motorways are already safer than comparable multilane highspeed roads (Transurban, 2025) and applying these rail sector approaches offers a practical pathway from evidence to action—supporting safer roads, more predictable journeys and stronger public confidence. Current motorway operations depend on coordinated ramp metering, variable speed management and real time information; however, adopting rail-style reliability measures would improve the consistency and transparency of performance monitoring. Key metrics that can guide this shift include journey-time reliability, incident clearance times, stopped-vehicle detection effectiveness, near-miss and crash rates, and network availability. Embedding these measures can help shape a safer, more reliable road network that delivers meaningful benefits for all communities.

Introduction
Understanding road safety performance has traditionally relied on metrics that describe crash outcomes – such as severity, crash type, road environment, vehicle characteristics and behavioural factors. While these indicators remain essential, managed motorways offer a far richer evidence base. Intelligent Transport Systems (ITS), including tolling systems, automatic incident detection and lane-use management systems, now provide detailed insights into speed profiles, lane compliance and following distance. Recent access to connected-vehicle data has further strengthened this dataset, enabling the identification of near-miss events such as hard braking and abrupt steering.

Opportunities to improve safety are increasingly found by applying approaches or frameworks from other transport sectors. In Australia, adopting rail sector performance methods across a network of nineteen managed motorways and tunnels is demonstrating early promise. Critically, a stronger focus on incident response – an often-underemphasised pillar of the Safe System approach in high income countries – offers a clear pathway to reducing risk on high-speed networks and improving outcomes for all road users.

Conference theme
This work addresses the ARSC2026 conference theme *From Evidence to Action: Shaping a Brighter Future* through applying an evidence-based framework from another transport sector, rail, to managed motorways.

Method
Across a managed motorways network of nineteen roads and tunnels in Australia, an average of 2.5 million trips per day (Transurban, 2025), and more than 1,000 incidents are managed per week. Trained Network Operators monitor and respond to incidents in asset-based traffic control rooms, managed through the application of traffic guidance schemes that reduce speeds and close lanes, alert motorists through variable message signs (VMS), radio re-broadcast and public announcement systems in tunnels, and deployment of dedicated incident response crews in truck mounted attenuators and tow trucks. The combination of these interventions aims to reduce the risk of injury to both motorists, and incident response crews, including secondary incidents, by returning the road to normal operations as quickly as possible.

In September 2025, a new performance measurement approach was implemented across nineteen managed motorways, centred on journey reliability adopted from the rail sector, defined by incident response and clearance times. Network Operators captured operational data through existing management systems, documenting all incident types – including crashes, stationary vehicles, debris, prohibited users and wildlife. These data were integrated into a daily Tableau dashboard that linked directly to incident logs (see Figure 1).

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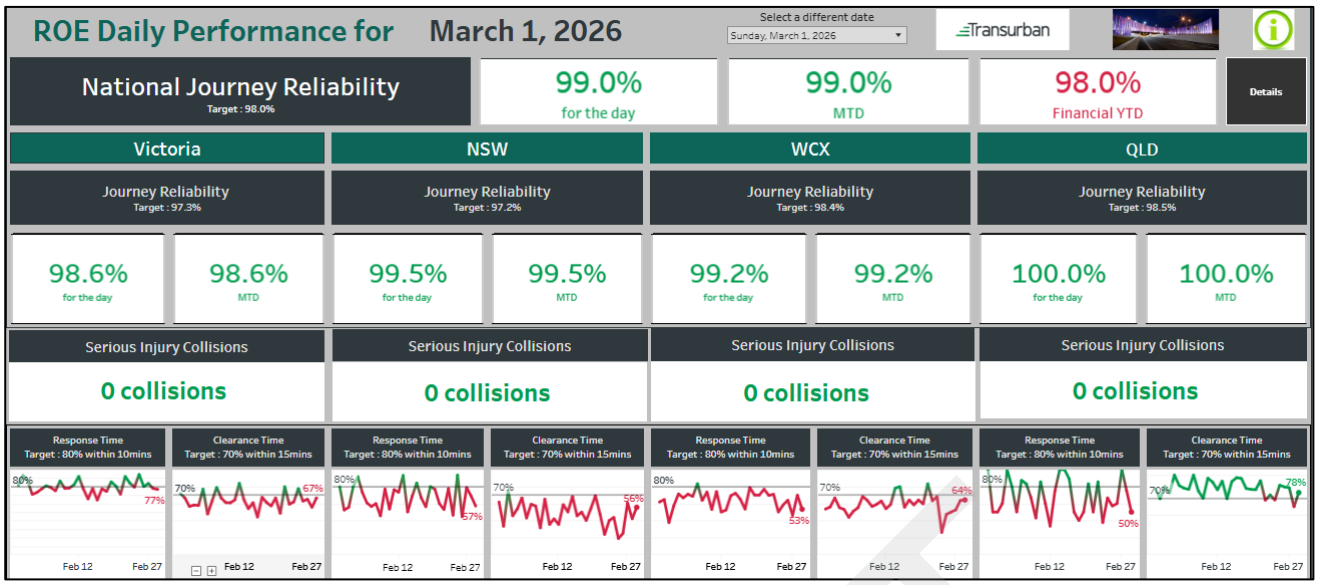

Figure 1. Daily performance Tableau dashboard
Source: Transurban (reproduced with permission)

Daily standup meetings brought together operational, road safety, HSE and asset management teams to review leading and lagging performance indicators, identify emerging trends and record actions in a shared planning tool. More serious incidents were examined in monthly cross functional reviews to determine improvement actions within the managed motorway operator's control or influence.

Findings

Applying journey reliability as a core performance measure across nineteen managed motorways and tunnels has shown early signs of improving road safety outcomes. This structured, iterative process enabled consistent monitoring of network performance and strengthened the evidence base for operational decision making. Daily performance reviews and monthly in-depth incident analyses helped identify recurring themes, including heavy haulage management, incident response staging, congestion patterns, and risks faced by motorists who stop, break down or are involved in crashes. For example, more detailed and consistent incident descriptions across traffic control rooms have improved the ability to identify common operational themes across motorway networks in each city (See Figure 2).

Before: Incident description with limited details

Start/Detected Time	Type and Id	Highlight Reason	Details	Further Details	Response Time	Clearance Time
1/10/2025 5:02:00 am	Stationary Vehicle (25QPR013928I)	Long Clearance	Black Ford Ranger, Gateway Mwy SB em bay L1 after POB on ramp at Bulimba Creek	Null	7 mins	17 mins

After: Incident description with full details

Start/Detected Time	Type and Id	Highlight Reason	Details	Further Details	Response Time	Clearance Time
25/2/2026 6:33:00 am	Stationary Vehicle (26QPR002954I)	Long Clearance	White Mazda 3, Gateway Motorway, NB, LS, Wynnum Rd on ramp	06:33:00 - Waze : SV, Gateway Motorway, NB, Wynnum Rd on ramp 06:34:00 - Ventia : Dispatched from Wynnum Rd 06:38:00 - Ventia : On approach 06:38:00 - Ventia : On scene LS 06:39:00 - Ventia : Advised driver was changing rear tyre..	5 mins	19 mins

Figure 2. Sample incident descriptions before and after performance measurement approach initiated
Source: Transurban (reproduced with permission)

Another example is the implementation of a 'load and go' trial in February 2026 for motorway vehicle breakdowns where vehicles are towed to safety rather than attempting to fix them on the roadside. This has resulted in an improvement in average arrival and clearance times in one region of between 1 minute and up to just under seven minutes across different road segments, compared to the prior four-month period. These early results have a positive impact on the safety of motorists and reduce the risk of secondary crashes.

This approach strengthened operational discipline through a clearer focus on controllable factors, consistent recording of actions in a shared planning tool, and integration of these actions into a Safe System-based road safety plan. The iterative refinement of incident response processes supported risk reduction for both motorists and operational crews.

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Importantly, the program delivered a consistent, enterprise-wide view of journey reliability, enabling common issues and trends to be identified across all roads and tunnels– rather than within isolated geographic regions – supporting more coordinated and effective safety improvements.

Benefits to road safety

The application of journey reliability as a core performance measure has demonstrated early, measurable benefits for road safety on managed motorways. By drawing on established rail-sector performance frameworks, the approach enabled a more proactive understanding of network risk – particularly through improved visibility of incident response times, near-miss indicators and operational trends.

The structured review process strengthened day-to-day operational discipline, supported faster and more consistent responses to incidents, and reduced exposure to secondary crashes for both motorists and incident crews. These improvements highlight how adopting cross-sector safety frameworks can enhance the Safe System approach, especially in relation to post-crash response on high-speed corridors.

Implications for policy and/or practice

The findings demonstrate clear opportunities for transport agencies and operators to embed journey reliability as a central performance metric in road safety governance. Incorporating response and clearance times into urban motorway/freeway performance frameworks would support more consistent monitoring of controllable risks and enable earlier intervention on emerging safety issues. The structured daily and monthly review processes provide a practical model for strengthening operational accountability and building an evidence-based road safety action plan.

More broadly, the results suggest that borrowing proven safety frameworks from other transport modes, such as rail, can accelerate policy development, improve public confidence and guide investment decisions aimed at reducing serious trauma on high-speed networks.

Conclusion

This project demonstrates that applying rail-sector reliability principles to managed motorways offers a practical and evidence-based pathway to safer and more predictable road networks. Early results show improvements in operational consistency, incident response and identification of enterprise-wide trends, supporting more coordinated safety management across all roads and tunnels in the network. Further work could focus on refining journey-reliability measures, integrating richer connected-vehicle data and evaluating long-term impacts on crash and near-miss rates. Together, these steps can strengthen the role of managed motorways in delivering a safer, more resilient transport system for all users.

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Crash severity analysis of vehicle interactions using multinomial logit models

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Abstract
Understanding the factors influencing crash severity is essential for improving road safety. This study analyses crash severity patterns using national road traffic crash data from Sri Lanka between 2010 and 2020. A multinomial logit model was applied to examine how environmental factors and vehicle combinations influence crash severity outcomes, categorized into four levels: damage-only, non-grievous injury, grievous injury, and fatal. Passenger vehicle–passenger vehicle crashes were used as the reference interaction. Results indicate that rural crashes are significantly more severe than urban crashes, while adverse weather and poor lighting substantially increase severity. Vehicle interaction types strongly influence outcomes, particularly crashes involving motorcycles and vulnerable road users. Heavy vehicle–motorcycle collisions demonstrate the most severe crash profile, with 57.7% resulting in grievous or fatal injuries. Fatal motorcycle crash odds increased to approximately 2.3 times the 2010 baseline by 2020, emphasizing the need for targeted interventions focusing on motorcycle safety and vulnerable road user protection.

Introduction
Road traffic injuries remain a major global public health challenge. The World Health Organization estimates that approximately 1.19 million people die in road traffic crashes each year, with 92% of deaths occurring in low- and middle-income countries (WHO Sri Lanka, 2023). Crash severity is shaped by driver, vehicle, roadway, and environmental factors, including rural setting, adverse weather, poor lighting, and impact speed (Sivasankaran et al., 2021). Motorcyclists are particularly vulnerable due to their limited physical protection, and in mixed-traffic environments, crash risk emerges from multiple interacting factors (Bédard et al., 2002). Despite growing literature on injury severity, few studies have examined how vehicle interaction types influence outcomes in South Asian settings. This study addresses that gap using national police-reported crash data from Sri Lanka (2010–2020), applying a multinomial logit model to evaluate environmental and vehicle combination effects on crash severity.

Conference theme
This study addresses the ARSC2026 theme, From Evidence to Action: Shaping a Brighter Future, by translating national crash data into quantitative evidence to guide road safety policy. The multinomial logit framework identifies the highest-risk road environments and vehicle interactions, providing an evidence base for targeted interventions including motorcycle safety programs, VRU infrastructure investment, and lighting improvements.

Method

Data Source
The analysis uses national crash data obtained from the Sri Lankan Road Traffic Crash Database for the period 2010–2020. Each crash record contains information on crash severity, location characteristics, environmental conditions, and the types of vehicles involved. Crash severity was categorized into four levels based on police-reported outcomes, with damage-only crashes used as the base outcome in the severity model. The multinomial logit model was estimated using the reference categories shown in Table 1. Model coefficients represent changes in log-odds, and the exponentiated coefficients provide odds ratios.

Vehicles were grouped into six categories to simplify vehicle interaction analysis: Passenger Vehicles (cars, dual-purpose vehicles); Motorcycles (motorcycle/moped); Three-Wheelers; Heavy Vehicles (lorry, articulated vehicle, SLTB bus, private bus, intercity bus, tractor); Vulnerable Road Users (cycle, pedestrian, animal-drawn vehicle); and Other (other/not known). Vehicle combinations were then derived from these groups to analyse interaction effects.

Results

Environmental effects on crash severity
The model results indicate that rural crashes are significantly more severe than urban crashes. Weather conditions also play an important role in crash severity. Lighting conditions also influence crash outcomes. Nighttime crashes without

street lighting are more than double the likelihood of fatal crashes, while poor street lighting increases fatal crash odds by approximately 2.3 times compared with daylight conditions. Table 2 presents the full odds ratios for all environmental predictors.

Table 1. Reference categories used in the multinomial logit model

Variable	Reference Category
Urban/Rural	Urban Area
Weather	Clear Weather
Light Condition	Daylight
Vehicle Combination	Passenger Vehicle vs Passenger Vehicle
Outcome Comparison	Each severity vs Damage Only (Severity = 0)

Table 2. Odds ratios for environmental predictors of crash severity

Variable	Severity	Odds Ratio
Rural Area (vs Urban)	Injury	3.19
	Grievous	4.02
	Fatal	3.94
Cloudy Weather (vs Clear)	Injury	1.56
	Grievous	1.60
	Fatal	1.39
Rainy Weather (vs Clear)	Injury	1.66
	Grievous	1.72
	Fatal	1.90
Fog / Mist (vs Clear)	Injury	2.64
	Grievous	1.32
	Fatal	4.71
Night – No Street Lighting (vs Daylight)	Injury	1.29
	Grievous	1.57
	Fatal	2.26
Dusk / Dawn (vs Daylight)	Injury	1.02
	Grievous	1.03
	Fatal	1.55
Night – Poor Street Lighting (vs Daylight)	Injury	1.17
	Grievous	1.47
	Fatal	2.28
Night – Good Street Lighting (vs Daylight)	Injury	1.20
	Grievous	1.31
	Fatal	1.75

Vehicle combination effects

Vehicle interaction types have a substantial influence on crash severity. Crashes involving motorcycles demonstrate significantly higher injury risks compared with passenger vehicle collisions. Crashes involving vulnerable road users pose an extremely high risk. The heatmap in Figure 1 illustrates the severity distribution across all vehicle combinations. The distribution of crash severity varies significantly across vehicle combinations. Passenger vehicle collisions produce the highest proportion of minor outcomes, with approximately 88.9% of crashes resulting in damage-only outcomes. In contrast, heavy vehicle–motorcycle crashes demonstrate one of the most severe crash profiles, with only 6% resulting in minor outcomes, while approximately 57.7% result in grievous or fatal injuries. Crashes involving vulnerable road users show the highest fatal proportions. Motorcycle-involved crashes also account for a large share of grievous injury crashes.

Temporal trends in crash severity

Temporal analysis indicates that the odds of injury and fatal crashes relative to damage-only crashes increased over time compared with the 2010 baseline (Figure 2). Grievous injury crashes showed the largest increase, reaching approximately 2.7 times the baseline by 2020. Fatal crashes also increased, reaching approximately 2.3 times the 2010 baseline.

Figure 3 shows that motorcycle crash severity has specifically increased over time relative to the baseline year of 2010. The largest increase is observed in fatal outcomes, suggesting growing vulnerability of motorcyclists in the road system, likely associated with increasing motorcycle usage and exposure.

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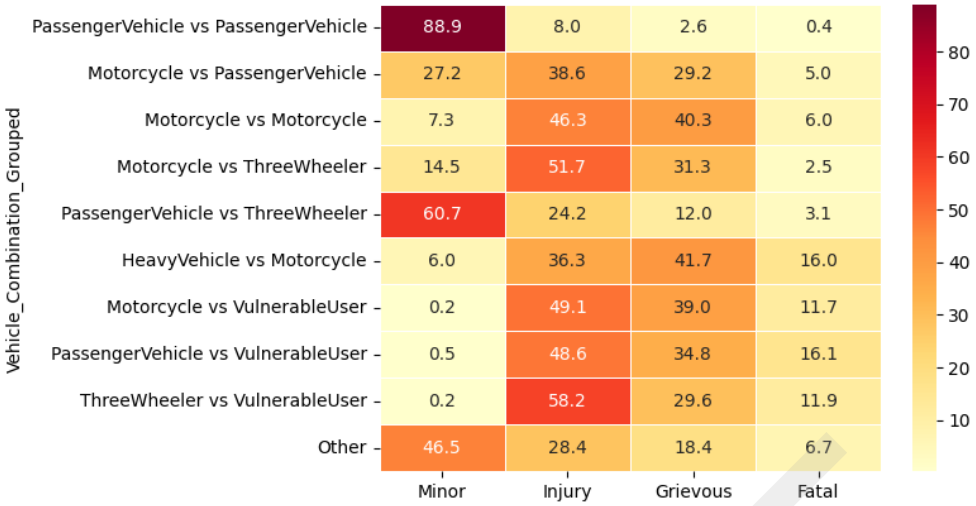

Figure 1. Heatmap of crash severity distribution by vehicle combination.
Darker colours indicate a higher proportion of crashes in that severity category

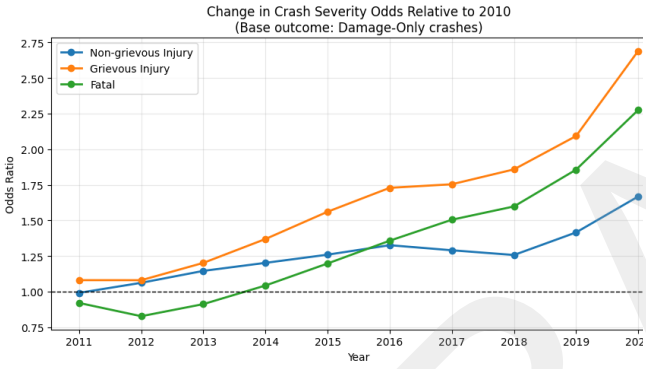

Figure 2. Temporal trends in crash severity crash severity relative to 2010 baseline

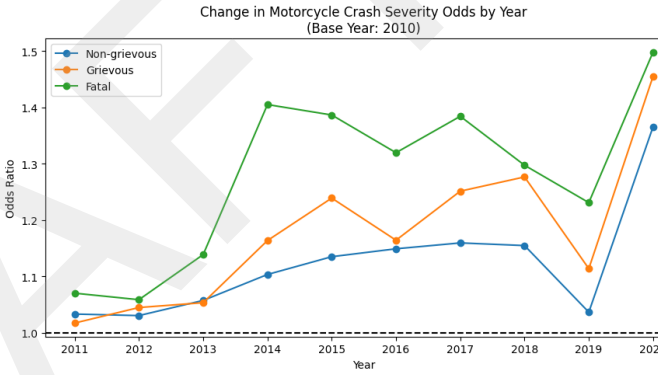

Figure 3. Temporal trends in motorcycle odds relative to the 2010 baseline

Benefits to road safety

This study identifies high-risk crash interactions, particularly those involving motorcycles and vulnerable road users, which contribute disproportionately to severe and fatal crashes. The findings provide evidence for prioritizing safety interventions targeting motorcyclists and vulnerable road users to reduce serious road trauma.

Implications for policy and/or practice

The results suggest the need for targeted motorcycle safety programs, improved protection for vulnerable road users, and better roadway lighting in high-risk areas. Strengthening helmet enforcement, improving pedestrian infrastructure, and enhancing rural road safety measures could significantly reduce severe crash outcomes.

Conclusions

The analysis shows that crash severity in Sri Lanka is strongly influenced by vehicle interactions and environmental conditions. Crashes involving motorcycles and vulnerable road users produce the highest injury severity levels, and motorcycle crash severity has increased relative to the 2010 baseline. Targeted safety interventions focusing on these high-risk groups are essential to reduce road traffic injuries and fatalities.

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From apprehension to action: improving responses to women's substance-impaired driving

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Abstract
Women represent a growing share of substance-impaired driving detections, yet little is known about their experience of apprehension, court processing, and penalties, and how this affects behaviour change. This qualitative study interviewed 35 women (aged 19–69 years) apprehended for drink and/or drug driving in Queensland. Thematic analysis identified four interconnected dimensions: *women's substance use narratives*; *mechanisms connecting use to driving; experiences and outcomes of apprehension and legal processing*; and *behaviour change support needs*. Accounts were heterogeneous, spanning incidental use, use embedded in psychosocial strain, and habitual or normalised use. Women described influences on substance-impaired driving, including misjudgment of substance levels, intoxication-related judgment changes, and mobility pressures related to work and caregiving. Legal experiences varied: sanctions supported change for some but compounded distress and disruption for others, suggesting unequal capacity for change. Findings indicate the value of integrating supportive pathways alongside punitive responses, particularly where psychosocial difficulty is prominent.

Background
Women account for a meaningful, although smaller, share of alcohol and drug-related road trauma in Australia, and are increasingly detected for drink and drug driving (AIWH, 2023; Mills et al., 2021). Although women's offending is often understood through a male-dominated lens that commonly frames substance-impaired driving around risk-taking, repeat offending, deterrence, and peer norms, emerging research suggests their substance-impaired driving more often occurs in relational and vulnerability contexts with co-occurring risk behaviours (Robertson et al., 2013; Webster et al., 2024). Previous qualitative research has found that women commonly link drink driving to habitual alcohol use to unwind or alleviate distress, frame their driving around short, everyday journeys, and rely on subjective assessments of impairment, with full recognition of the seriousness of their behaviour often occurring after apprehension (Armstrong et al., 2020). Armstrong et al. (2026) further identified different pathways into drink and drug driving among women: a pathway characterised by gendered psychosocial complexity (for example, problematic substance use, mental illness, caregiving pressures, and domestic violence), a pathway involving misjudgement of intoxication, and a high-risk pathway characterised by permissive norms, repeated traffic violations, and limited responsiveness to legal sanctions.

Together, this previous research has begun to clarify the circumstances in which women engage in substance-impaired driving and highlight heterogeneity in pathways to this behaviour. What remains less understood is how these circumstances shape women's experiences once they come into contact with the legal system following apprehension, and what this means for their capacity to change their behaviour. Addressing this gap, the present qualitative study examines Queensland women's experiences of drink and/or drug apprehension, court processing, penalties following apprehension, and support needs for behaviour change. This study is the first phase of a broader program that uses lived experience to inform subsequent work with key stakeholder groups to support translation into practical responses.

Conference theme
The findings of this study are intended to inform dialogue with stakeholders across road safety, enforcement, legal, and health systems regarding how responses to women's substance-impaired driving might be strengthened. By sharing women's lived experiences, the study advances a women-centred understanding of substance-impaired driving and behaviour change needs, addressing a gap in the literature that has often treated substance-impaired driving as gender-neutral or implicitly male. This perspective highlights where existing approaches may not align with women's circumstances and where alternative responses may be warranted.

Method
Semi-structured telephone interviews were conducted with 35 Queensland women (aged 19–69 years) with a drink and/or drug-driving conviction in the past five years. Participants were recruited using paid advertisement. Interviews explored substance use and substance-impaired driving histories, experiences of the apprehension event, and any behaviour change following apprehension. Interviews were transcribed verbatim, and data were analysed inductively using thematic analysis.

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Results and Interpretation

Data was organised into four interconnected dimensions: (1) women's narratives of substance use; (2) how substance use translated into substance-impaired driving; (3) the experience of apprehension; and (4) support needs for behaviour change and recovery. Supporting quotations are presented in Table 1.

Table 1. Key Dimensions and Example Quotations From the Interviews

Narratives of substance use	**Quotation 1:** I'd just left my husband at the time. It was a lot of domestic violence going on in that marriage and trying to escape. I felt like I couldn't physically escape, so obviously, alcohol and drugs were the second option. (Drink and drug driver, age 31)
From substance use to substance-impaired driving	**Quotation 2:** There's a mouthwash that you can get that neutralizes the pH levels in your mouth. (Drug driver, age 36)
	Quotation 3: I don't ever believe that I was impaired enough to be arrested for anything, whereas if you had to smoke the same amount of pot as me, you might have been. (Drug driver, age 56)
The experience of apprehension	**Quotation 4:** I was feeling like I was hanging in there and holding everything together well, and then suddenly it's like, "No, you can't drive anymore, you're such a terrible person for driving with marijuana in your system. Get off our roads." That just really undermined a lot of my feelings of self-worth and my ability to cope. (Drug driver, age 50)
	Quotation 5: Never again. I've had enough shame from this one time to last me until the day I die. (Drug driver, age 41).
Support for behaviour change and recovery	**Quotation 6:** I was in the highest risk category, having been released from prison, having been come from this background of DV, being a parent, so many different factors, and no one could help me. (Drug driver, age 36)
	Quotation 7: All along the process, it was nobody's job to help. (Drink driver, age 60)

Narratives of substance use

Women described substantial heterogeneity in the meaning and role of substance use. A small group characterised their use as occasional and unremarkable. Many, however, described their use as embedded in psychosocial strain, including trauma, domestic violence, grief, mental health difficulties, caregiving pressures, and financial stress. For these women, alcohol or drugs functioned as self-medication, relief, or escape (**Quotation 1)**. A third pattern, found among drug drivers only, reflected habitual or normalised use sustained over time, sometimes framed as recreational or as functional self-management, with some acknowledgement of dependence.

Interpretation: These differences suggest women arrive at legal system contact with different meanings attached to their substance use, differing readiness for change, and distinct support needs.

From substance use to substance-impaired driving

Women described multiple influences shaping the transition from substance use to driving. These included misjudging the levels of substance in their system, underestimating detection likelihood, a perceived ability to avoid a positive drug test (**Quotation 2**), the impact of acute intoxication, and the gradual erosion of boundaries over time. Among drug drivers, normalisation of drug use and beliefs that drug effects were manageable (**Quotation 3**), or even beneficial for driving, were common. For some frequent users, driving after use was framed less as deliberate risk-taking and more as a mobility necessity to sustain work and caregiving responsibilities.

Interpretation: These mechanisms represent plausible proximal targets for road safety intervention, but the accounts also indicate these mechanisms were often embedded within broader life contexts that shaped women's capacity to act on risk knowledge.

The experience and outcome of apprehension

Experiences of apprehension, court, and penalties varied and appeared shaped by the same heterogeneity evident in women's substance use narratives, including differing vulnerabilities, resources, and capacity to respond. Post-apprehension trajectories ranged from deterrence (ceasing substance use or separating use from driving) to continued offending, and in some cases, withdrawal from driving alongside worsening substance use.

Some participants, particularly those with repeated prior apprehensions, described these events as manageable; however, most characterised the apprehension and its consequences as daunting and unpleasant. Women who were already experiencing psychosocial strain described a deterioration of pre-existing vulnerabilities, including threats to employment and caregiving, and escalation of distress (**Quotation 4**). In some cases, this reinforced substance use and continued substance-impaired driving. Shame operated differently across accounts, functioning as a deterrent for some (**Quotation 5)**, but contributing to withdrawal and increased substance use as a coping strategy for others.

Interpretation: These findings suggest uniform sanctions may generate unequal capacity for behaviour change, with differing implications for ongoing risk.

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Support needs for behaviour changes and recovery

While some women remained unmotivated to change, others recognised a need to address underlying substance use and broader life difficulties. These women described individual and systemic barriers that shaped their capacity to seek help. Individual barriers included shame, self-punitive beliefs, concealment, limited readiness to change, and practical constraints linked to work and caregiving. Systemic barriers included service scarcity (**Quotation 6**), long waitlists, siloed treatment pathways, and forms of exclusion (including perceived healthcare stigma and exclusion). Some women described legal and healthcare system contact points (e.g., police, court, or hospital following crash injury) as missed opportunities for inquiry, referral, or support, particularly when underlying distress or harmful use was visible (**Quotation 7**).

Interpretation: Together, the accounts suggest that road safety risk reduction may be strengthened by integrating supportive pathways alongside punitive responses, especially where substance-impaired driving is one manifestation of broader psychosocial difficulty.

Benefits to road safety

By strengthening our understanding of women's experiences and support needs, the findings of this study contribute to a knowledge base to inform practical responses, addressing an area where current efforts are limited by a lack of women-specific understandings.

Implications for policy and/or practice

This study centres women's lived experience to identify the supports they associate with behaviour change following apprehension and legal system contact. Findings are intended to inform subsequent engagement with stakeholders, including policymakers, about what practical interventions could be implemented to better meet women's expressed needs for behaviour change support following an apprehension.

Conclusions

Participants' accounts highlight heterogeneity in women's experiences, influences, needs, and capacity for behaviour change at the point of legal system contact. Findings identified proximal influences on substance-impaired driving (e.g., impairment and detectability perceptions, and decision points), but these are often shaped by broader life contexts.

Future work. Findings indicated that uniform sanctions may produce unequal capacity for behaviour change. This field would benefit from investigation into how supportive responses alongside deterrence mechanisms may benefit women, particularly when psychosocial difficulty is present.

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DRAFT

Impact protection of wearable airbag vests for motorcyclists

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Abstract
Wearable airbag vests have recently entered the motorcycle protective gear market to address rising rates of serious thoracic injury. However, real-world evidence is limited, and consumers cannot readily compare product performance. This study evaluated seven airbag vests using chest and shoulder impact tests on a human surrogate. Performance varied, with the best vests reducing chest compression by 27% and shoulder force by 25%. While the results demonstrate potential to reduce thoracic injury, they highlight the need to review certification standards or introduce independent testing to better inform riders and encourage improved performance. Further research should assess crash detection and triggering systems as well as inflation times.

Introduction
Passive protective gear for motorcycle riders, such as helmets and protective clothing, reduces injury risk, but protection against thoracic impacts remains limited. As head protection has improved, the burden of serious chest injuries has increased (Bambach & Mitchell, 2014). These injuries occur in impacts with vehicles, fixed objects, or the road, often to the front or side of the chest and shoulder at 35-48 km/h (Deville et al., 2026).

Wearable airbag vests have emerged on the market to address this gap, aiming to detect a crash and rapidly inflate to reduce impact forces. Products vary in trigger systems (mechanical or electronic) and coverage. Although some meet existing performance standards, concerns remain about whether these standards adequately assess protection (Aranda Marco, 2022; Cherta-Ballester et al., 2024).

Most evidence on wearable airbags comes from simulations, showing performance depends on inflated thickness, pressure, shape of the impacted object, and velocity (Thollon et al., 2010; Cherta-Ballester et al., 2021; Aranda Marco, 2022). Limited real-world crash and experimental data suggest protection may be restricted to 30–40 km/h (Serre et al., 2019), with chest deflection reductions of 7–36% in impact testing of current products (Wehrmeyer et al., 2023). Observational studies show mixed findings: increased injury risk in equestrian sports (Meyer et al., 2023) and no significant reduction in fatality risk for powered two-wheeler riders, though usage was low and product differences unaccounted for (Saint-Louis et al., 2025). This study aims to assess the impact protection offered by commercially available wearable airbag vests.

Conference theme
Motorcycle riders are overrepresented in road trauma, with serious torso injuries common due to limited protection. Although wearable airbags are marketed to improve protection, their real-world effectiveness remains uncertain and current certification tests may be inadequate. This work contributes to *From Evidence to Action: Shaping a Brighter Future* by providing evidence on wearable airbag performance to inform action for refining certification standards, guiding regulatory updates, and supporting safer consumer choices.

Method
Seven commercially available airbag vests were tested in impacts to the front and side of the chest, and the side of the shoulder of an Anthropomorphic Test Device (ATD), or test dummy. Where possible, calibration impact test procedures were used due to the known, repeatable response and corresponding injury assessment metrics available. The primary measurements of interest were ATD chest compression, shoulder force and impact probe force, while ATD head acceleration, neck force and moment, chest acceleration and pelvis acceleration were also recorded. For the frontal impacts and side chest impacts, risk of Abbreviated Injury Scale (AIS) 3+ thoracic injury was calculated using the Hybrid III and EuroSID-2re injury assessment reference values (IARVs).

Airbag vests
Test samples are detailed in Table 1. Impacts were conducted without a vest (see Figure 1), as well as with each vest sample both uninflated and approximately 1 second after being triggered to inflate. Electronically triggered vests were activated at the inflator, while the lanyard was pulled to trigger the mechanically activated vest. Side shoulder and chest impacts were only conducted on vests where the airbag coverage extended to these areas, see Table 1.

Frontal chest impact test setup
The Hybrid III 50th percentile male ATD was seated on a flat smooth bench. An impact probe weighing 23.4 kg with a circular flat impact face of diameter 152 mm and edge radius 12.7 mm was aligned so that the centre impacted the chest

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of the ATD 12.7 mm below the mid-height of the number 3 rib (see Figure 1a). Impacts were conducted with a probe velocity of 6.7 m/s.

Table 1. Airbag vest samples tested

Airbag vest	Triggering mechanism	Certification standards listed	Shoulder coverage	Side chest coverage
Helite e-Turtle 2	Electronic	CRITT-SL protocol no. AMC-012:02/2020 EN 1621-2:2014 Level 2 Full back protector	No	No
Alpinestars Tech Air 5	Electronic	EN 1621-4:2013 Level 2 Central back requirements EN 1621-2:2014 Level 1 Central back protector	Yes	Yes
Alpinestars Tech Air 7x	Electronic	EN 17092-6:2020 Class C undergarment EN 1621-4:2013 Level 2 Central back requirements EN 1621-2:2014 Level 1 Central back protector	Yes	Yes
Alpinestars Tech Air Offroad	Electronic	EN 17092-6:2020 Class C undergarment EN 1621-3:2018 Level 1 Full chest requirements EN 1621-2:2014 Level 1 Full back requirements EN 1621-3:2018 Level 2 Full chest protector EN 1621-2:2014 Level 1 Full back protector	Yes	Yes
Dainese SmartAir	Electronic	EN 17092-6:2020 Class C undergarment EN 1621-4:2013 EN 1621-3:2018 Level 2 Divided chest requirements EN 1621-2:2014 Level 2 Central back requirements	No	No
Klim Ai-1	Electronic	EN 17092-6 Class C undergarment EN 1621-2:2014 Level 1 full back protector	No	No
HitAir MLV	Mechanical (lanyard)	EN 1621-4:2013 Level 1 Full back protector	No	No

Side shoulder impact test setup

The EuroSID II 50th percentile male ATD was seated on a flat smooth bench. The same impact probe was aligned so that the centre impacted the centre pivot of the upper arm axis (ie. the pivot arm bolt) of the ATD (see Figure 1b). Impacts were conducted with a probe velocity of 5.5 m/s.

Side chest impact test setup

The EuroSID II 50th percentile male ATD was seated on a flat smooth bench. An extension was added to the face of the above-described impact probe to avoid any unintended interaction between the probe and the ATD arm. The extension had a rectangular flat face with dimensions of 70 mm by 150 mm with an edge radius of 5 mm and weighed 1 kg bringing the total impact probe weight to 24.4 kg. The impact probe was aligned so that the centre of the extension impacted at the mid-height between the middle and lower ribs (see Figure 1c). Impacts were conducted with a probe velocity of 5 m/s.

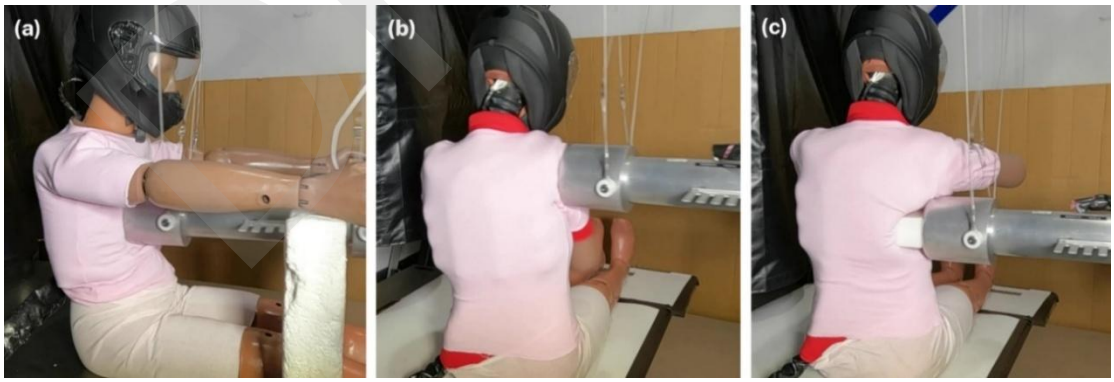

Figure 1. Impact configurations for the frontal chest impacts (a), side shoulder impacts (b) and side chest impacts (c)

Results

The chest compression results and corresponding risk of AIS 3+ thoracic injury for frontal and side chest impacts are shown in Figure 2. In frontal impacts, chest compression reduced by -1% to 27% when tested with the inflated wearable airbags, which changed the risk of serious thoracic injury from 85% down to 9% in the best case. In side impacts, chest compression reduced by 0% to 6% with the inflated airbag vests, which changed the risk of serious thoracic injury from 32% to 26% in the best case.

In side shoulder impacts, shoulder force was reduced from 2221 N when unprotected, down to between 1897 N (15% reduction with TechAir Offroad) and 1672 N (25% reduction with TechAir5).

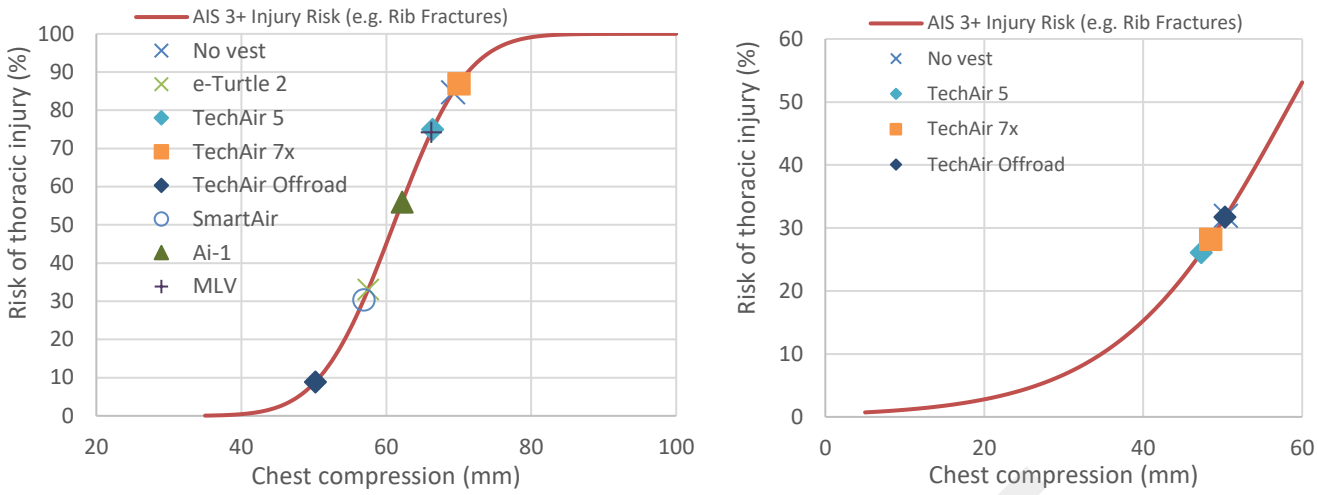

Figure 2. Chest compression and risk of AIS 3+ thoracic injury for frontal chest (left) and side chest (right) impact tests

Benefits to road safety

This study adds to the growing evidence of injury saving potential of wearable airbags for motorcycle riders and highlights clear policy and practice implications detailed below.

Implications for policy and practice

The variable performance of airbag vests indicates a need for policy or practice changes to ensure optimal rider protection. This may include strengthening certification standards to raise minimum performance requirements or introducing independent assessments and clearer consumer information to help riders choose products suited to their riding conditions.

Conclusions

Commercial airbag vests can reduce chest compression and shoulder force in torso impacts, though performance varies between products. These findings alone cannot provide clear conclusions on the effectiveness of airbag vests due to important limitations. The ATD calibration type impacts used here provided repeatable test conditions suitable to assess product differences but do not replicate real crashes, which involve tangential as well as normal impact velocities (Deville et al., 2026). In addition, vests offer very little protection if uninflated at impact. This study did not evaluate crash detection and triggering systems or inflation time, which require further research to inform clear recommendations.

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DRAFT

Unlocking proactive Black Spot funding with Safe System Assessments

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Abstract
Relying exclusively on reactive funding models solely based on crash history like the traditional 'Black Spot' approach will not deliver a Vision Zero future. As serious crashes are highly dispersed and rarely recur at the exact same locations, particularly on lower-volume networks, waiting for trauma to occur hampers network-wide safety improvements. To address this, risk evaluation methodologies such as Safe System Assessments (SSAs) are a vital step towards proactive funding. SSAs evaluate infrastructure alignment with Safe System principles during early project phases, guiding foundational design choices to eliminate fatalities and serious injuries. This paper outlines how the author successfully applied SSAs to secure Black Spot funding for two proactive local government projects in South Australia without needing to meet traditional casualty crash eligibility requirements. By integrating SSAs into the nomination process, road authorities can overcome the limitations of reactive approaches and proactively invest in improvements towards a harm-free road network.

Background
The Australian Government's Black Spot program has successfully funded safety infrastructure at thousands of sites since 1996. Historically, this reactive approach reduced trauma by targeting locations with established casualty crash histories and Benefit Cost Ratios (BCRs) of at least 2.0. However, this formulaic reliance on past crashes to predict future trauma is becoming less effective. The strict BCR requirement incentivises narrow treatments that resolve specific historical crash types but may potentially compromise the safety of other users who are not represented in the crash data, often pedestrians and cyclists. This stifles holistic, Safe System-aligned interventions that are designed to proactively optimise safety outcomes for all road users simultaneously.

Furthermore, waiting for crash patterns to establish incentivises a flawed mindset by practitioners to prioritise treatments that merely reduce crash likelihood, rather than aim to eliminate the risk of trauma. Serious crashes are highly dispersed, particularly on lower-volume rural and remote networks, and rarely recur at the exact same locations. This makes it difficult for jurisdictions with lower traffic volumes to rely on reactive methods, ultimately hampering efforts to improve safety at a network level (Durdin & Alavi, 2024). While the program has been highly successful at reducing overall road trauma, the reactive approach is becoming less effective as locations that meet the crash criteria are increasingly difficult to identify (Joint Select Committee on Road Safety, 2022).

Since 2008, the author has secured funding for 47 Black Spot projects, with 45 of these using the traditional reactive BCR approach. With each of these projects involving three or more casualty crashes, these 45 successful nominations have relied on at least 135 people being killed or injured to secure funding.

The Australian Government has recognised the need to encourage proactive road safety investment, updating the program's guidelines in 2024 to recommend that state and territory jurisdictions nominate at least 30 per cent of their funding towards proactive projects (Department of Infrastructure, Transport, Regional Development, Communications and the Arts, 2024).

This abstract summarises how the author successfully nominated two projects in South Australia in November 2024 that were supported by Safe System Assessments (SSAs) without needing to meet the reactive requirement of at least three casualty crashes occurring within the most recently available five-year period. While the integration of SSAs into funding prioritisation may be established in some states, it has historically not been standard practice across most Australian jurisdictions. Within South Australia, applying SSAs to bypass traditional casualty criteria represents a novel and highly proactive approach for local government practitioners.

Conference theme
With 2030 rapidly approaching amid five years of increasing road trauma statistics, the evidence is clear that we need to urgently adopt proactive infrastructure investment to transition towards Australia's Vision Zero targets. Road safety funding programs such as the Australian Government's Black Spot program have typically relied on crashes to occur to identify viable and eligible projects. Securing proactive funding with Safe System Assessments (SSAs) can help transform road safety funding into action towards a harm-free future on our roads.

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Method

SSAs evaluate how effectively an infrastructure project aligns with Safe System principles and are highly valuable during the early concept and scoping phases of a project, as fundamental adjustments to the design and scope are more readily accommodated at the beginning of the process. While road safety audits offer similarly effective insights, SSAs are better suited to scoring and ranking the alignment of treatment options against the core principles of the Safe System approach. The two sites identified for funding involved road safety issues adjacent to schools. SSAs were conducted in November 2024, led by the author (a trained Safe System Assessor) using a risk-scoring matrix that quantified exposure (based on traffic volumes and vulnerable road user presence), likelihood (assessing hazards, conflict points and infrastructure safety), and severity (evaluating operating speeds and impact angles) across seven specific crash types (Department of Planning, Transport and Infrastructure, 2019; Turner et al., 2016). SSA reports were submitted as the primary evidence in the Black Spot nominations, acting as a substitute for traditional Benefit Cost Ratio calculations and approach.

The first site on Bains Road involved a lack of driver compliance at a Pedestrian Actuated Crossing (PAC) when children were crossing the road under the pedestrian phase. Due to the presence of another signalised intersection approximately 150 m west of the PAC, poor driver compliance was likely to be associated with westbound motorists mistakenly observing a green signal at the intersection just beyond the PAC. A red light camera at the PAC identified at least 25 instances of westbound vehicles disobeying a red signal during peak morning and afternoon school times over the 2023–24 financial year, confirming the legitimacy of the safety concern. The SSA for this project considered two design options, both based on increasing the conspicuity of the PAC traffic signals. The first design option involved the installation of a new traffic signal mast-arm and the second involved the installation of a new concrete median to accommodate a new standard traffic signal post in the centre of the roadway, as well as provide a staged crossing opportunity for pedestrians.

The second site on Murrays Hill Road involved vehicles travelling past the school's frontage at unsafe speeds, especially during busy drop-off and pick-up times. A 25 km/h school zone currently operates in association with a school crossing, spanning approximately 50 m either side of the crossing. Due to highly prescriptive South Australian requirements for this type of school zone, the council was not permitted to extend its length beyond its current extents in an attempt to address the broader speeding issue. The SSA for this project considered a single design option involving the installation of series of vertical-deflection devices to restrict vehicle speeds to around 25–30 km/h along approximately 270 m of the school's frontage.

Results

Both SSAs demonstrated that the proposed design options achieved improved safety outcomes. Noting that a lower score indicates increasing alignment, the SSA for Murrays Hill Road reduced the risk score from 128 (out of a maximum of 448) for existing conditions to 32 for the proposed traffic calming scheme. This project employs a primary Safe System treatment that physically reduces vehicle speeds to 30 km/h, reducing the likelihood and severity of all crash types that were considered. The 75 per cent reduction provided compelling evidence that physical speed restriction to around 30 km/h would practically eliminate the risk of high-severity pedestrian crashes, demonstrating a critical outcome that traditional reactive metrics could not forecast.

The SSA for Bains Road was less conclusive. The mast arm design option reduced the risk score for existing conditions from 132 to 116, as pedestrian crash types were the only category with a changed score owing to the reduced likelihood of crashes associated with this treatment. The design option involving a new central median and traffic signal post however reduced the overall risk score to 104 with a more significant reduction in the likelihood of pedestrian crashes due to the new signals being more prominent in the middle of the carriageway, as well as the refuge providing pedestrians with the opportunity to stage crossings of the road. However, as shown in Figure 1, the run-off-road crash risk had a slightly higher score for this option as the refuge would introduce a new hazard within the roadway. Conversely, the score for head-on crashes was slightly lower as the refuge would physically separate the vehicles travelling in opposing directions.

Ultimately, the comparative SSA scores provided critical design insights, indicating that while a new mast arm marginally improved safety, the central median design option provided the best outcome. This justifies the proposed investment as the primary purpose of this project is to improve safety for children crossing the road. In December 2025 the Australian Government announced 20 projects for South Australia that were successful in receiving Black Spot funding, including $100,700 for Bains Road and $154,500 for Murrays Hill Road.

Benefits to road safety

These proactive nominations demonstrate how it is possible for councils to secure vital road safety funding through the Black Spot program without needing to wait for crashes to identify viable and eligible projects through this funding program. By using an evidence-based approach to assess risk proactively, we can unlock this funding opportunity into action to help realise our shared Vision Zero goals.

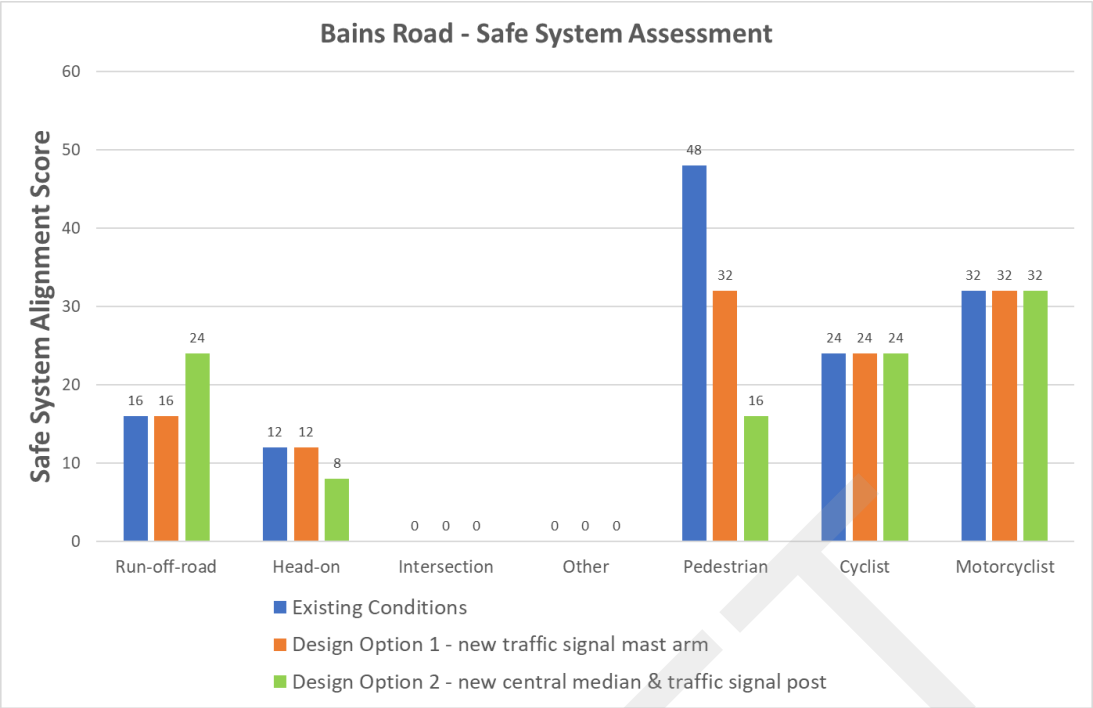

Figure 1. Example Safe System Assessment scores by crash type for two design options on Bains Road
Source: Bains Road Safe System Assessment report (prepared by abstract's author)

Implications for policy and/or practice

The Australian Government have updated the Black Spot program's criteria to recommend that at least 30 per cent of Black Spot funding is allocated to proactive nominations that are evaluated with recognised assessment methodologies. This abstract demonstrates that local governments do not have to wait for crashes to identify eligible sites and that proactive funding is possible by supporting nominations with Safe System Assessments.

Conclusions

While the Black Spot program's main reliance on reactive, crash-based criteria has been effective in delivering widespread infrastructure improvements since the 1990s, this approach is not viable for achieving Vision Zero. This is because serious trauma is highly dispersed, resulting in councils struggling to secure funding for lower-volume roads without an established crash history. As demonstrated by the two successfully funded projects outlined in this abstract, embedding SSAs into the nomination process provides a highly effective alternative. By conducting SSAs during early scoping phases, councils can secure vital investment proactively and ensure their infrastructure fundamentally aligns with the goal of eliminating fatal and serious injuries on our roads.

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An economic assessment of safer speeds as a pedestrian safety intervention

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Abstract
This submission summarises the outcomes of an economic assessment of safer speed limit options as a key pedestrian safety intervention. The aim of the work was to build a framework and evidence to support road managers looking to these interventions. The assessment considered posted speed limit changes in different hypothetical scenarios primarily in urban areas. The analysis suggests that there is likely to be a strong case for safer speed limits, particularly in areas where the existing crash risk is relatively high and in areas of high pedestrian use. In particular in environments of high place value or on roads adjacent to major trip generators. The benefits of lower speeds for existing pedestrian users can be large and tend to dominate the assessment. The analysis also focussed on identify critical assumptions that drive the result and areas where further evidence and data would add value and increase the robustness of assessments.

Introduction
The analysis formed part of the broader Austroads project SAG6371 Keeping People Safe When Walking which aims to help chart a path to zero pedestrian serious trauma by establishing a greater level of understanding and insight into pedestrian safety risk, trauma, and cost-effective countermeasures.

The analysis supported this objective by undertaking an economic assessment of safer speed limit options in primarily urban areas – as a key pedestrian safety intervention. The aim is to build a framework and evidence to support Austroads' members looking to assess pedestrian focused speed limit interventions. Specifically, it presents economic assessments of speed limit reductions in a range of different hypothetical contexts to help identify whether there is a strong case for safer speed limits in these contexts, the key drivers of outcomes and areas where further evidence and data would add value to jurisdictions considering these reforms.

Conference theme
This project focussed on building the evidence base to aid road managers undertaking economic assessments of speed limit changes. Economic assessments or cost benefit analysis are critical to achieving policy change as they are a required by many jurisdictions as part of broader regulatory and policy reform processes.

Methodology
This economic assessment applied a cost-benefit analysis (CBA) methodology. A CBA is an assessment approach that compares the costs (or disbenefits) and benefits associated with an intervention for society. The CBA was undertaken for 12 different scenarios, which reflect speed limit interventions (typically in urban environments) that were considered most likely to reduce crashes involving pedestrians.

Scenarios were developed that differed in terms of the starting speed limit, the scale of the speed limit change and the nature and context of the road network being affected. These scenarios represented a reasonable characterisation of the types of speed limit changes that road managers may consider to improve pedestrian safety. For this reason, the scenarios mostly focus on environments with lower speed limits in urban areas.

The assessment considered the impacts on all users of a road corridor and society in general. Therefore, the analysis includes consideration of the additional vehicle travel time that might result from a reduction in speed limits, the avoided crash and road trauma costs for society and the improvements in pedestrian amenity and mobility resulting from this change.

Findings
The findings of the CBA were clear. All 12 scenarios tested had a benefit-cost ratio (BCR) of more than one – implying the benefits for society outweighed the costs. The key takeaway from this analysis is that there appears to be a strong economic rationale for pedestrian focused speed limit reductions in a range of urban settings.
The results of the CBA are summarised in Table 1. For comparison, the table shows the ratio of:

- avoided crash costs to the vehicle travel time disbenefits
- avoided crash costs plus pedestrian amenity and severance benefits to the vehicle travel time disbenefits.

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Table 1. CBA results summary – benefit-cost ratios

Scenario		Avoided crash costs only	Avoided crash costs plus pedestrian amenity and severance benefits
1	Local residential streets (50 to 40 km/h)	1.8	5.1
2	Local residential streets (50 to 30 km/h)	1.1	2.6
3	Peri-urban/rural link (60 to 50 km/h)	1.8	2.0
4	Peri-urban/rural link (80 to 60 km/h)	1.0	1.1
5	Activity or destination high streets (high Place value, medium Movement value) (50 to 40 km/h)	1.7	5.0
6	Activity or civic/destination high streets (high Place value, medium to low Movement value) (50 to 30 km/h)	1.0	5.9
7	Civic spaces/city places (40 to 30 km/h)	0.5	8.1
8	Urban connectors/arterial high street (60 to 50 km/h)	2.5	2.88
9	Adjacent to major trip generator/drop off pick up point (50 to 40 km/h)	1.7	68.3
10	Adjacent to major trip generator/drop off pick up point (60 to 40 km/h)	2.8	51.2
11	Adjacent to schools (40 to 30 km/h)	0.5	5.0
12	Peri-urban/rural link road adjacent high-risk areas (100 to 80 km/h)	1.1	1.2

When ignoring additional pedestrian benefits (i.e., amenity benefits and reduced community severance) and instead focussing only on avoided crash costs to vehicle travel time disbenefits some of the scenarios do not generate benefit-cost ratio (BCR) of greater than 1.0 (i.e. benefits that exceed costs). The key assumption affecting this result is the starting or base case FSI crash rate. The key takeaway from this is that, all things being equal, speed limit reductions deliver greater benefits when applied in areas where the starting crash rate is relatively high.

When extending the analysis to focus on the pedestrian-related benefits (using emerging approaches in ATAP(2024) for valuing these benefits) these tend to dominate the assessment and drive far higher BCRs and net benefits. These benefits are associated with improved amenity for pedestrians and reduced community severance – which arises from the traffic speed being less of a barrier to pedestrians accessing goods, services and people in their community. These benefits vary depending on the specific road environment being considered with the relative number of pedestrian trips to vehicle trips being a key assumption driving the results. The scenarios with the highest BCRs are all where pedestrian movements are critical and relatively high. For example, on activity or destination high streets with high Place value, in civic spaces or adjacent to major trip generators where there are high numbers of pedestrian movements.

The results were largely insensitive to a range of key uncertainties, except for the assumptions made with respect to traffic flow and the degree to which it was impeded by other factors such as intersections and junctions. The analysis could be considered conservative in that it did not include benefits to cyclists or benefits arising from induced active transport demand or from modal and route shifts. This was due to a lack of data and evidence available to inform the estimation of these second order benefits. However, a case study on this benefit found that these impacts are likely to be relatively small in value when compared to the benefits arising to existing pedestrians (see Figure 1). On the other hand, the analysis does not include any implementation costs. For simplicity, the analysis is purely for a change in the posted speed limit on a small segment of road, rather than any broader infrastructure changes (e.g. traffic calming infrastructure). As such, the excluded implementation costs (associated with signage for the new speed limit) albeit this is not fundamentally expected to affect the findings.

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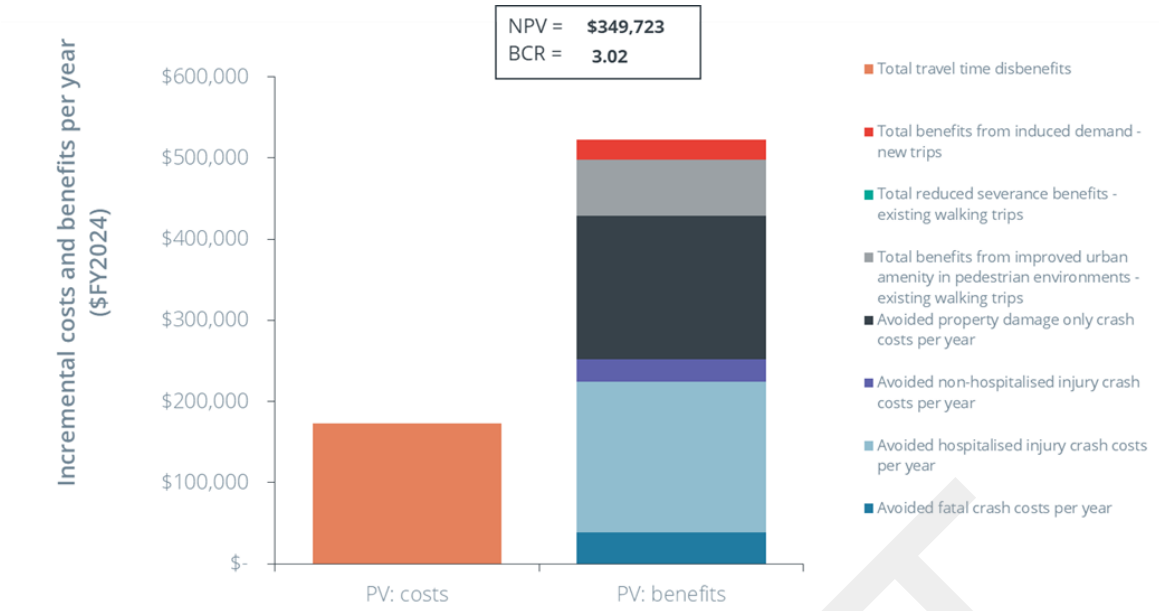

Figure 1. Results of the CBA for the arterial high street (60 to 50 km/h) scenario (incl. induced demand)

Implications for policy and/or practice

The analysis suggests that there is likely to be a strong case for safer speed limits, particularly in areas where the existing crash risk is relatively high and in areas of high pedestrian use. Importantly it provides a framework and evidence to support transport agencies looking for opportunities to reduce speed limits on road links that are critical for pedestrians. This therefore has the potential to help road managers identify beneficial areas for safer speed limits and implement these changes.

Conclusions

This assessment highlights that the pedestrian focused benefits of safer speed limits could be substantive and suggests that there is likely to be a strong case for safer speed limits. Importantly this work provides a framework and evidence to support transport agencies looking for opportunities to reduce speed limits. It also makes the following recommendations for next steps:

1. Transport agencies should continue to look for opportunities to reduce speed limits on road links that are critical for pedestrians.
2. Jurisdictional road safety strategies and supporting road safety action plans should have regard for their local context when considering pedestrian focused speed limit reductions. However, they should focus on identifying opportunities for speed limit reductions on road typologies with relatively higher number of pedestrians to vehicle movements and where the existing crash rate is relatively high when compared to other relatively low speed urban or peri-urban road environments.
3. Jurisdictions, and the forthcoming Austroads Guidance on Speed Management, should give further consideration to whether and when speed limit reductions are better implemented as default changes (i.e. generalised across the same road typology) or localised changes in posted limits.
4. Jurisdictions should consider building better data and evidence on the following, as this would allow for future analysis of pedestrian focussed speed limit reductions to be refined:
    - cash rates, both within and between different urban and peri-urban road typologies
    - typical pedestrian and active transport demand for different road typologies
    - the extent of property damage only crashes in different speed and road environments
    - the extent to which vehicle movements and travel times are typically impeded by other elements of the urban road network, such as stopping at intersections
    - the impact of speed on severance.

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Contributing factors to fatal crashes: a Safe System analysis

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Abstract
Road deaths in New Zealand have remained stubbornly high for the past 10 years. Building on previous work, a Safe System analysis of 200 fatal crashes was carried out to better understand the contributing factors and how these factors come together in crashes. We found that road fatalities almost always involved multiple system failures. Approximately half of fatal crashes involved reckless/extreme behaviours often in conjunction with other system failures, while a third were attributed to system failures and everyday mistakes alone. Six fatal crash profiles were identified through a cluster analysis. Notable findings include a potential increase in drug involvement and decrease in alcohol involvement, higher speed environments without protective features, mismatches between operating speed and speed limits, a range of vehicle considerations, and significant motorcyclist and pedestrian involvement. The research underscores the need to address all Safe System elements to reduce fatal crashes, even when reckless behaviour is present.

Background
Road deaths in New Zealand (NZ) have reduced significantly since the mid-1980s but have remained stubbornly high at around 300-350 deaths per year for the past 10 years (Ministry of Transport, 2026). Beyond the tragic loss of life each death represents, there is also a profound ripple effect on families, friends, and communities. These tragedies also carry significant economic costs, including lost opportunity and income, health care expenses, and traffic delays.

The Safe System approach has framed contemporary road safety efforts in NZ (Ministry of Transport, 2010), and internationally. In addition to key principles, the four main pillars of the Safe System are safer roads and roadsides, safe speeds, safe road use, and safe vehicles. These pillars have been used in NZ and international studies to examine the involvement of each pillar in the immediate crash context to gain insights into how elements from across the Safe System contribute to crashes (Hirsch et al., 2017, Hirsch et al., 2021; Mackie et al., 2017; McTiernan et al., 2019; Raja et al., 2023; Wundersitz et al., 2014; Wundersitz & Raftery, 2025).

Mackie Research was commissioned by the New Zealand AA Research Foundation to build on and update a Safe System analysis of fatal crashes and how they come together in crashes. Specifically, this project addresses the following research questions:

1. What are the Safe System determinants of fatal road crashes in NZ, as defined by previous research?
2. What proportion of crashes result from everyday mistakes and 'system failures', compared with crashes where illegal or reckless/extreme behaviour was involved?
3. What are the implications of the findings for policy, and practice?

We acknowledge that the Safe System approach focusses on both deaths and serious injuries. However, serious injury data in NZ covers a wide range of situations, with a large range of injuries considered 'serious'. Therefore, there are substantial variations in the circumstances in which these crashes occur. Given the resources available for this intensive analysis, a focus on fatal crashes was chosen, to better understand the most severe crashes that happen, within a relatively homogeneous and manageable dataset.

Conference theme
This research gives further clarity to the Safe System contributing factors to fatal crashes, strengthening our evidence for how these crashes emerge, but also the logic for actions that will actually make a difference in reducing road trauma. The research also reinforces a 'whole of system' approach to road safety, which can be used in evidence-based communication and policy.

Method
Two hundred fatal crashes from across NZ in 2024 were randomly sampled, representing 80% of all crashes that year. Sampling was carried out separately for two 100 crash cohorts 'light-vehicle-only' and 'all-other' which included all road users. A Safe System framework developed based on earlier work (Mackie et al., 2017; Raja et al., 2023; Wundersitz & Raftery, 2025), guided the analysis, with specified contributing factors triggering each pillar- roads and roadsides, speed environment, vehicles, and users. Data for each contributing factor was sourced from Traffic Crash Reports but also supporting datasets to obtain vehicle features, road, roadside, and speed environment characteristics. Descriptive statistics were produced for the full sample and each cohort.

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Crashes were also classified based on the presence of different road user behaviours in the crash circumstances. The definition of each of these classifications is provided below, based on Wundersitz et al. (2025):

- **'System failures'** - people making mistakes and the wider Safe System not preventing a fatality.
- **'Illegal system failures'** – an illegal but not reckless/extreme behaviour along with mistakes and wider Safe System failures which contributed to the fatality.
- **'Reckless/extreme behaviour'**- multiple illegal behaviours or deliberate violations such as exceeding the permitted alcohol levels or significant speeding.

A cluster analysis was conducted to identify contributing factors that often co-occur, hence providing profiles of typical fatal crash circumstances. This analysis was carried out using Hierarchical Clustering on Principal Components following a multiple correspondence analysis of selected key variables.

Findings

The analysis found that road fatalities almost always involved multiple system failures (99% of sample crashes), with 56% of crashes having failures in all four Safe System pillars implicated. Figure 1 shows that approximately half of fatal crashes involved reckless/extreme behaviours, while a third were attributed to system failures and everyday mistakes alone. Importantly, most crashes involving reckless/extreme behaviours also exhibited multiple failures across the Safe System pillars. This suggests that crashes involving 'reckless/extreme behaviour' should not be viewed as road user problems alone and the wider system context needs to be considered.

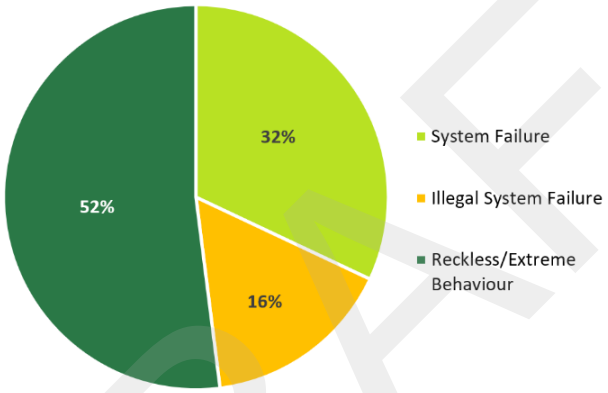

Figure 1: Proportion of crashes classified as system failures, illegal system failures, and reckless/extreme behaviours in fatal crashes (n= 200).

Other notable findings include a potential increase in drug involvement and decrease in alcohol involvement, higher speed environments without protective features, mismatches between operating speed and speed limits, a range of vehicle considerations, and significant motorcyclist and pedestrian involvement.

Six fatal crash profiles were identified through the statistical cluster analysis of all 200 crashes:

Crash type		% of crashes	Details
	Single vehicle- run off road	28%	After losing control on high-speed rural roads lacking roadside barriers and with operating speeds often much lower than the speed limit. Majority at night with young developing drivers overrepresented. Intoxication, speeding and seatbelt non-use often involved. Reckless behaviours in over half of cases.
	Multiple light vehicles	25%	Mostly head-on impacts on high-speed rural roads lacking centre barriers. Young drivers and those driving illegally by license were overrepresented. Intoxication featured prominently alongside speeding and distraction. Strongly shaped by reckless or illegal behaviour alongside other system failures.
	Large vs small vehicles	**15%**	High mass vehicles colliding with light vehicles in head-on crashes mostly on high-speed rural roads lacking centre barriers and less so at intersections. Mostly middle-aged full licensed drivers. Frequently involved distraction/ inattention and/or speed. Mostly mistakes and system failures and less so reckless behaviour.

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	Vehicle struck pedestrian/ cyclist	**11%**	Predominantly on urban arterial roads at intersections or driveways. Infrastructure such as safe crossings and footpaths often missing. Often middle-aged and fully licensed drivers. Distraction/ inattention was the dominant contributing factor. Most cases involved system failures without reckless behaviour.
	Vehicle struck motorcycle	**11%**	Most often at intersections on urban and rural roads. Riders and drivers who were inexperienced and held illegal licenses were prevalent. Intoxication and distraction/inattention were dominant factors, with speeding and extreme behaviour also implicated. Often illegal/reckless behaviours by the motorcyclist.
	Motorcycle-run off road	**10%**	After losing control on rural and urban roads with operating speeds often much lower than the speed limit. Most were riders were middle-aged, with inexperienced riders notably overrepresented. Speed and intoxication were frequent contributors. Reckless/illegal behaviour was more common than system failures alone.

Benefits to road safety

This more fine-grained Safe System understanding of fatal crashes provides an evidence-based for effective road safety interventions across the system and allowing resources to be focussed where they are needed most. This will ultimately lead to more effective harm reduction for any given level of investment.

Implications for policy and/or practice

This research further confirms that fatal crashes occur when multiple system failures coincide, underscoring the need to address all Safe System pillars to reduce fatal crashes, even when reckless behaviour is present. Although this analysis was for fatalities only, previous work has shown this also applies to serious crashes (Mackie et al., 2017).

The findings also reinforce that road users often make mistakes which can inadvertently lead to severe consequences. However, the need for a more nuanced understanding of the road user contribution to the Safe System is also suggested. Increased presence of drugs is a possible trend, although this is complicated by changes in the reporting of drug use in Traffic Crash Reports over time. Attention should be given to better understanding reckless/extreme behaviours, the trends that drive them, and interventions to reduce these behaviours among road users, within a wider Safe System focus. Earlier analyses demonstrate how socio-technical analyses may be better suited for understanding the 'upstream' and societal trends that may be driving dangerous behaviours but also lack of other protective road and vehicle elements (Raja et al., 2023).

The work also highlighted many situations where road infrastructure or speed limit shortcomings have contributed to road users losing their lives in a range of settings. This suggests harmonisation between road safety infrastructure and speed is needed so that protection and consistency at a national scale can be achieved. The vehicle contribution to fatalities is also clear from the research and greater clarity about vehicle safety issues and associated education, incentives, and changes to regulatory settings are needed, focusing on vehicle age and safety features, mismatches between vehicle masses in collisions, and the aggressivity of vehicles in vulnerable road user collisions. Finally, given that vulnerable road users (motorcyclists, pedestrians, and to a lesser extent cyclists) were involved in around a third of the crashes, continued focus is needed on these groups.

Conclusions

This Safe System analysis has confirmed that multiple system failures are almost always involved in fatal crashes. Reckless and illegal behaviours are also often involved but rarely in isolation of other system factors. System failure clusters in fatal crashes have been demonstrated in six typical crash profiles, which provides guidance for corresponding road safety programmes. A better understanding of 'upstream' system factors using socio-technical systems methods is needed, to understand why Safe System failures continue to happen.

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Cameras or Cops: What deters drivers from speeding?

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Abstract
Speeding is a leading contributor to fatal and serious injury crashes, and enforcement is central to deterrence. In Australia, speed limits are enforced through automated speed cameras and face-to-face police interception. While both approaches are widely used, limited research compares their deterrent effect on recidivism, particularly across speeding severity levels. This study analysed 4.39 million speeding offences in South Australia (2005-2023), linked to over one million licensed drivers. Prentice-Williams-Peterson-gap-time-Cox model analysis examined time to first reoffence following automated and face-to-face enforcement. Drivers detected via automated enforcement had a 21.2% higher risk of reoffending. Among recidivists, face-to-face enforcement delayed reoffending by an average of 172 days. The effect of face-to-face enforcement was substantially stronger for higher-level speeding offences, with delays to reoffence markedly longer compared to camera-detected offences. These findings indicate targeted face-to-face enforcement may strengthen deterrence, particularly for high-risk speeding behaviour, highlighting opportunities to strengthen enforcement strategies and operational practice.

Introduction
Speeding is a significant contributor to fatal and serious injury crashes, and enforcement is a key countermeasure used to deter this behaviour (Tay, 2009; Bates et al., 2020). In Australia, speed limits are primarily enforced using two methods: automated enforcement and face-to-face police interception. Automated enforcement includes both fixed and mobile speed cameras. In South Australia, fixed cameras are permanently installed at locations that are preceded by advance warning signage. In contrast, mobile speed cameras in South Australia operate covertly, with no advance signage warning drivers of their presence. Offenders detected by either system are notified through an automated mailed infringement process.
Face-to-face enforcement involves the use of police-operated speed detection equipment (e.g., radar or laser devices) to measure a vehicle's speed, followed by interception of the driver. This process results in a direct interaction between the officer and driver. Officers may issue either a caution or an expiation notice and can explain the reason for the stop. This human interaction may influence perceptions of fairness, risk, and consequences, consistent with procedural justice (e.g., Bates et al., 2022). However, face-to-face enforcement is more resource intensive than automated methods.

While both enforcement approaches are widely used, limited research has examined how they differ in their ability to deter repeat offending, particularly across levels of speeding severity. This distinction is important because higher-level speeding is associated with substantially greater crash risk and more severe injury outcomes. Understanding whether automated or face-to-face enforcement produces stronger deterrent effects, especially among higher-risk offenders, can inform how enforcement resources are deployed to maximise road safety benefits. Accordingly, this study compared recidivism following automated and face-to-face enforcement, both overall and across levels of speeding severity.

Conference theme
This study aligns with the ARSC2026 theme *From Evidence to Action: Shaping a Brighter Future* by delivering robust empirical evidence, in collaboration with police, to inform enforcement strategy and operational practice. The findings offer new insight into how enforcement approaches can be deployed more strategically to strengthen deterrence, particularly for high-risk speeding behaviour, with implications for road safety policing in Australia and internationally.

Method
Administrative speeding offence data from South Australia (2005-2023) obtained from the Department for Infrastructure and Transport (DIT) and the South Australian Police (SAPOL) were analysed. The dataset included 4,394,551 offences matched to licence numbers for 1,099,022 licensed drivers. Offences without valid individual licences (e.g., business registrations) were excluded. Offences were classified by enforcement mode (automated camera or face-to-face police interception). Face-to-face outcomes were further classified as expiations or cautions. Offences were grouped by severity according to the amount the speed limit was exceeded (0-9 km/h, 10-19 km/h, 20-29 km/h, 30-44 km/h, and 45+ km/h), consistent with police categories.

Time to first reoffence following each offence was analysed using Prentice-Williams-Peterson (PWP) gap-time Cox model analysis for *all offenders*, including those who did not reoffend during the study period. This approach allowed inclusion of single-offenders and accounted for participants whose follow-up ended before reoffence, periods of licence suspension, or death, without removing them from the analysis. To further examine differences among those who

reoffended, descriptive statistics (mean and median days to next offence) were calculated for recidivist offenders only. These comparisons were conducted by enforcement mode and within each speeding severity category.

Results

Automated enforcement accounted for 78.2% of detected offences, while face-to-face enforcement accounted for 21.8%. Of face-to-face interactions, 76.8% resulted in expiations and 23.1% in cautions.

All offenders

PWP Cox model analysis (Figure 1) showed that offenders detected via automated enforcement were more likely to reoffend sooner than those intercepted face-to-face. Drivers detected by camera had a 9.4% higher risk of reoffending compared with those subject to face-to-face enforcement (cautions and expiations combined) ($p < .001$), however, when the model was adjusted for driver age, sex and offence speeding severity, the hazard of reoffending following an automated enforcement increased to 21.2% ($p < .001$). This indicates that face-to-face enforcement was more effective at delaying subsequent speeding offences.

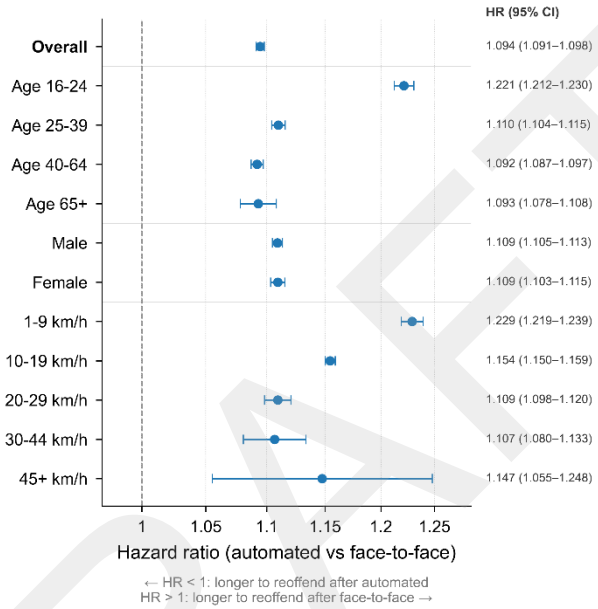

Figure 1. PWP Cox model analysis comparing time until reoffence for various enforcement methods

Reoffenders only

Approximately 67% of offenders committed another speeding offence during the study period. Among these recidivists, those initially detected face-to-face reoffended later on average than those detected via automated camera (Table 1). Face-to-face enforcement increased time to next offence by an average of 172 days (approximately 5.7 months). Within face-to-face enforcement, expiations delayed reoffence longer than cautions, with a median difference of 100 days (approximately 3.3 months).

Table 1. Recidivist offenders from each initial enforcement type and the general statistics regarding their subsequent offence

Days until next speeding-related offence	Initial enforcement type			
	Automated	Face-to-face		
		All	Expiations	Cautions
Mean days	760	932	962	800
Standard deviation	916	1,025	1,051	892
Median days	425	571	591	491

The magnitude of difference between enforcement modes increased progressively with speeding severity (Figure 2). For higher-level speeding offences, face-to-face enforcement was associated with substantially longer times to reoffence. Differences were smaller for low-level offences. For the highest severity category (45+ km/h over the limit), while noting penalties were equivalent across enforcement modes, face-to-face enforcement was associated with a 579-day (approximately 1.6-year) longer period before reoffence compared to automated enforcement.

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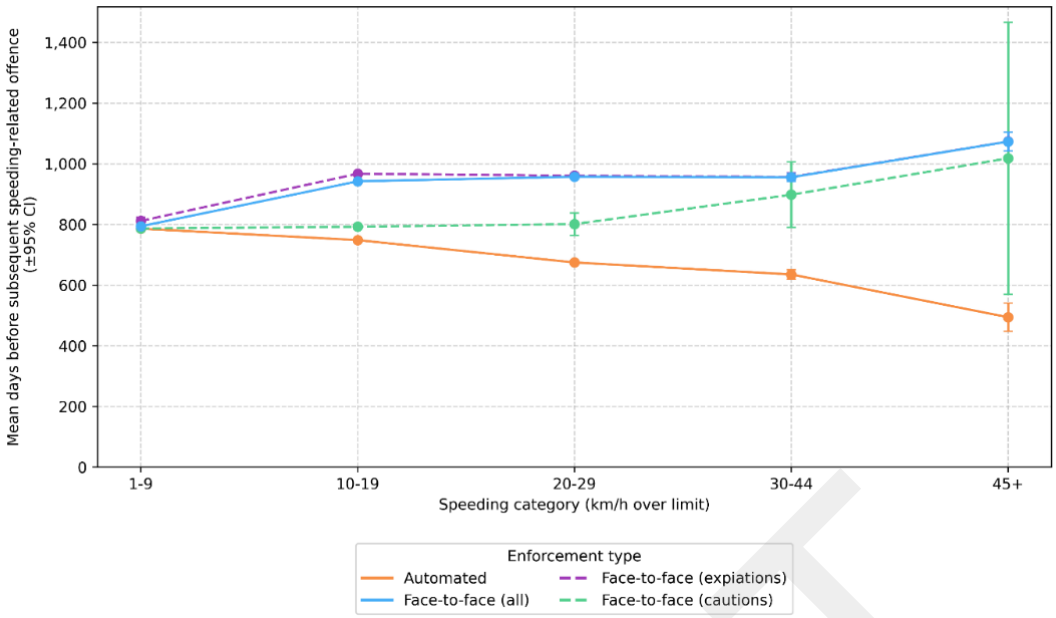

Figure 2: Mean days to subsequent speeding offence, by speeding category and enforcement type

Benefits to road safety

Automated enforcement enables large-scale detection and plays an important role in general deterrence. However, this study demonstrates that face-to-face enforcement is particularly effective in delaying repeat offending, especially among higher-severity offenders. Given the strong relationship between high-level speeding and severe crash outcomes, reducing repeat high-range speeding has significant potential to lower crash risk and improve road safety.

Implications for policy and/or practice

Automated enforcement continues to play a critical role in providing broad network coverage through high-volume, continuous speed monitoring, strengthening perceptions of the certainty of detection. However, the findings suggest that face-to-face enforcement has a stronger specific deterrent effect, particularly among higher-severity speeding offenders. While this analysis identified face-to-face interactions as more impactful, the mechanisms underpinning their effectiveness are not yet fully clear. Insights from procedural justice research suggest that in-person encounters may function as important educational moments. Police officers are able to explain the risks associated with unsafe driving and suggest safer alternatives, while also allowing drivers to share their perspective. Such reciprocal communication can enhance perceptions of fairness and respectful treatment, fostering greater trust in police and promoting compliance with road rules. It may also reinforce the link between the offending behaviour and its consequences. In addition, the immediacy of detection and the issue of a caution or expiation notice may amplify the deterrent effect, consistent with deterrence theory, as the experience is likely to feel more direct and personally relevant. This is particularly relevant for high-speed behaviour, where intervention at the point of occurrence may not only deter future offending but also reduce the immediate risk of a crash.

Based on these findings, enforcement operations may benefit from:

- Incorporating enforcement mode into risk-based policing strategies.
- Prioritising interception of high-range speeding offences where operationally feasible.
- Maintaining automated enforcement for broad coverage.
- Using a complementary approach to maximise overall deterrence.

Conclusions

Both automated and face-to-face enforcement reduce speeding, but their effects differ. In this study, face-to-face enforcement was associated with longer delays before repeat offending, particularly among higher-severity offenders. These findings are already informing police strategies in South Australia, enabling more targeted enforcement to strengthen deterrence and improve road safety outcomes.

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Evaluating Road Smart Interactive Processes and Engagement

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Abstract
Road Smart Interactive (RSI) is an interactive road safety education incursion developed by the Transport Accident Commission (TAC). In 2025, an independent process evaluation of RSI was commissioned to assess the effectiveness of the program's implementation and delivery, and to identify potential program improvements. RSI is a free, evidence-based, technology-rich road safety education incursion program developed by the TAC and delivered in partnership with Museums Victoria. The program is delivered as part of the Victorian Government road safety partners' Whole of School Community (WoSC) approach, which integrates road safety into all aspects of school life and aims to help school communities develop and maintain sound road safety knowledge and practices. Overall, the program was reported as being of a high standard in terms of delivery, student engagement and learning, with very high levels of participant satisfaction and positive shifts in intended behaviours following participation. Some improvements were also highlighted for consideration.

Background
Vulnerable Road Users, which include children and young drivers, is one of the strategic focus areas under the *Victorian Road Safety Strategy 2021-2030* (Department of Transport, 2021). The first Road Safety Action Plan under this Strategy included a commitment to developing a new strategic approach to best-practice road safety education. As part of this, the Victorian road safety partners — the Transport Accident Commission (TAC), Department of Transport and Planning (DTP), and Victoria Police — commenced implementing a Whole of School Community (WoSC) approach. This evidence-informed approach offers a range of programs, resources, and support activities to help school communities take a clearer, more proactive path in their road safety efforts. The WoSC model spans all education settings from Early Childhood to Year 12, and targets audiences including young and novice drivers, families, local government, and the broader community. The resources include curriculum-linked lessons, road safety programs, targeted resources, policy templates, and professional development for educators.

Road Smart Interactive (RSI) was developed by the TAC and is delivered by Museums Victoria. It contributes to the WoSC model by delivering immersive digital learning in secondary schools throughout Victoria, targeted at Years 9 to 11 and students undertaking the VCE Vocational Major. Through six interactive experiences, students explore the Safe System and consider their role as road users travelling to and from school each day. School visits run for up to five days, enabling meaningful engagement with students, school leaders, parents and carers, and the broader school community. Program participants are encouraged to consider the role of the Safe System in achieving zero lives lost on Victorian roads and use this built knowledge to contribute to a discussion around what they and their school can do to play their part in achieving this goal.

Conference theme
RSI addresses the ARSC2026 conference theme *From Evidence to Action: Shaping a Brighter Future* through the demonstration of how road safety evidence can be translated into engaging, applied learning experiences for young people. Its immersive design makes understanding the Safe System tangible, with evaluation findings indicating that participants not only build knowledge but also show a shift toward intending to adopt behaviours that support safe road use, highlighting RSI's potential to influence behaviour change. Its delivery within school communities encourages system-wide action. Through collective participation, RSI sparks school-wide conversations and action related to safe travel and shared responsibility, showcasing how evidence-based education can be operationalised across the state to shape safer school communities.

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Project description

Having launched in 2023, and following several years of operation, the TAC commissioned a mixed-methods process evaluation to understand how the program is being implemented in Victorian secondary schools, to what extent delivery reflects the intent of the program design, and to identify improvements for the program into the future (McIntyre, 2026). The evaluation examined four core themes:

- Appropriateness - Is the RSI content, scope and presentation style appropriate?
- Reach - Is RSI reaching the target audience?
- Dose - Is the incursion duration appropriate and part of an integrated road safety education program?
- Fidelity - Is the implementation consistent with the original planned intent?

Data were collected during Terms 3 and 4 in 2025 using multiple sources to capture classroom experiences and school-level uptake, including:

- 433 post-session surveys for students to understand levels of engagement and learning
- 88 teacher and coordinator surveys/interviews on relevance, delivery quality and how RSI fits with curriculum, policies and wider school activity
- 11 session audits of key messages, delivery sequence and facilitation
- Documentation of booking and enquiry pathways, operational processes and technical performance.

Survey data were summarised, qualitative feedback was thematically analysed, and observation checklists were collated to describe delivery consistency. Findings were triangulated across sources to build a coherent view of implementation quality, the scale, quality and equity of delivery, and the conditions that support schools to embed RSI within a Whole-of- School Community approach.

Results

The evaluation and analysis of the survey data was undertaken by McIntyre (2026) against the four core themes. Firstly, the content, style, delivery approach and duration of the program were explored through the student surveys, teacher surveys, coordinator surveys and in coordinator interviews. Data showed that among all surveyed groups, levels of satisfaction with the overall program were very high. The survey data showed satisfaction among:

- 88% of students,
- 100% of teachers
- 100% of coordinators

Among coordinators and teachers, the likelihood of booking again and recommending RSI was also very high, ranging from 94-100%. Students generally agreed that the program was relevant to them and that they could understand it. Over 80% reported they liked using the technology, and over 70% indicated that RSI was interesting to them. The majority of students agreed that they learned something new about the key messages the program was intended to deliver (i.e. how roads can be made safer, the influence of speed on crash severity, vehicle safety features, behaviours that increase risk, and achieving the zero target). Importantly, a majority also reported they would be more likely to adopt behaviours that support safe road use, particularly those relating to their own actions (68%) and influencing family and friends (66%). More than half also reported an intention to continue road safety conversations beyond the session (58%).

The level of interest in road safety among the schools that hosted the RSI incursion was also explored. Encouragingly, teachers and coordinators reported a high level of interest at their school for road safety education generally and for advocacy or supporting student advocacy. Specific road safety actions that can be undertaken by schools were explored with the coordinators, and of the schools:

- Over 80% communicate with parents about travel and parking
- Over 60% have a policy around students driving to school
- Almost 60% reported that road safety is embedded into other policies.

Regarding the reach of the program, in 2025, RSI was delivered to 12,000 students in 709 sessions at almost 140 schools. A third of the schools were from regional Victoria, and RSI reached across the school sectors (i.e. Government, Catholic and Independent), showing that the program is reaching a variety of schools and students. Direct communication from RSI and word of mouth were most frequently cited when coordinators were asked about how they found out about the program. It was identified that there are opportunities to increase awareness of the program and the supporting resources. Continuing to target teachers and school leaders through existing communication channels (e.g. email, professional associations/conferences) is critical to increasing awareness of the program.

The qualitative research confirmed that the advantages of RSI were that it comes directly to schools, is free of charge, is able to accommodate the number of students required, and fits into the school timetable.

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In order to determine whether the program was being delivered as intended, observational audits of the RSI sessions were undertaken. Overall, most of the key components of the program were covered, including the 4 pillars of the Safe System and the vulnerability of the human body in a crash. Small improvements were identified around the delivery of the 2050 zero target. Generally, most of the information communicated and program delivery was evidence-based and consistent with what was intended. While some technical issues arose during some sessions, they were generally minor and had minimal impact on the overall of the delivery of the program; workarounds were found in most cases. These occasional glitches are expected of a program that relies heavily on technology (which is a major drawcard for the students and teachers). Teachers and coordinators almost universally reported that the program ran smoothly (96%) and the facilitators were knowledgeable and engaging (100%). Overall, schools were very much satisfied with the delivery of the program by facilitators.

Benefits to road safety

Road Smart Interactive aims to enhance foundational Safe System understanding and encourage behaviours that support safe road use among young people, while strengthening whole-school engagement with road safety. Its immersive format increases comprehension, relevance and retention, while its in-school delivery ensures statewide equity of access. By reinforcing school policies, curriculum content and community conversations, RSI can support safer behaviours and contribute meaningfully to the WoSC vision of safer travel for all young people.

Implications for policy and/or practice

RSI offers a scalable and impactful model for embedding road safety learning within school communities. Its free and mobile design enables equitable access across metropolitan, regional and specialist settings. By complementing school-level actions and reinforcing shared responsibility messages, RSI strengthens the WoSC framework and supports long-term improvements in attitudes towards road safety in school communities.

Conclusions

After several years of operation, a process evaluation of RSI showed that the delivery and content of the program were appropriate, engaging, relevant and of the right length. There were high levels of satisfaction with the program and in its delivery by the facilitators. Students also reported they learned something new and most indicated they would be likely to adopt behaviours that support safe road use, suggesting the program's potential to translate learning into shifts in attitudes and behaviours. However, data from the facilitator audits and student surveys indicated that understanding key messages around the zero target and how students could be road safety advocates could be strengthened.

In 2025, the program reached around 12,000 students from around 140 schools, and capacity exists in the program to raise further awareness of the program and the supporting curriculum-linked resources. For those schools that engage with RSI, they are generally interested in and supportive of road safety, with leadership often employing whole-school actions, such as communication with parents/guardians and implementation of policies to support road safety. The data also showed that there is room to embed road safety activities around RSI and to incorporate it in a comprehensive road safety education curriculum.

Overall, the program was reported by teachers, students and coordinators to be of a high standard in terms of student engagement and learning. While very positive, there are some improvements that could be made to its delivery, along with wider awareness of the program and its resources.

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Towards proactive safety management: identifying key crash-risk precursors for Queensland motorways

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Abstract
Identifying motorway crash risk during adverse weather is essential for proactive safety management, which includes Weather Responsive Variable Speed Limit (WVSL). Existing WVSL systems are largely based on engineering judgement, with limited scientific evidence available to calibrate key VSL parameters. To address this gap, this study investigates the impact of weather conditions on motorway safety. Using Queensland as a case study, crash risk modelling is conducted to quantify the relationship between weather, traffic conditions, and crash occurrence. The results show that light rain is positively associated with crash risk, while greater downstream variability in speed and volume is also linked to higher crash odds. These findings provide a foundation for real time crash risk prediction models and support the use of predicted crash risk to trigger WVSL strategies.

Background
Inclement or adverse weather refers to atmospheric conditions that are worse than normal and can quickly reduce efficiency, and reliability and safety on motorways by lowering visibility and deteriorating road surface conditions. It can also influence drivers psychologically, increasing variation in driving behaviour and potentially affecting judgement (Guo et al., 2022). Variable Speed Limit (VSL) control is among the most widely used active traffic management strategies on motorways (Vrbanić et al., 2021) primarily deployed to harmonize vehicle speed and enhance safety. It has been successfully implemented in Europe, the USA, and Australia to improve traffic safety and mitigate congestion (Carlson et al., 2010). Empirical evidence shows that VSL implementation has reduced crash frequency by 15 to 26 percent, primarily by encouraging drivers to slow down before reaching downstream disturbances (Hasan et al., 2023).

Weather Responsive VSL (WRVSL) systems adjust speed limits for traffic flow and in response to weather conditions. An ideal WRVSL system should reduce crash likelihood in inclement weather by aligning speed limits with reduced visibility, lower road friction, and altered driver behaviour. However, most current smart motorway algorithms are optimized for normal traffic and do not account for the hazardous, dynamic nature of adverse weather and the risks it creates. For instance, in rainy conditions, friction and visibility decrease significantly, and if VSL systems do not adjust speeds to reflect this increased risk, drivers may travel too fast for prevailing conditions, increasing crash risk. Addressing this deficiency is vital for both safety and efficiency under adverse environmental conditions. While conventional VSL systems have shown effectiveness in normal traffic, their limited response to adverse weather creates a critical safety gap. By embedding traffic safety considerations into dynamic speed control, WRVSL can help close this gap, mitigate crash risks, and reduce associated economic losses, supporting safer and more resilient motorway operations.

This safety gap can be modelled scientifically by quantifying the crash risk through real time crash risk prediction models (RTCPM). These models have been based on a hypothesis that the likelihood of crash risk can be estimated by observing the fluctuations in the traffic and weather conditions in real time, generally 5 to 10 minutes before the crash has occurred (Hossain et al., 2019). With the advancement in technology, by leveraging the real time traffic and weather data, several methods been developed to estimate the crash risk of the motorways and intersections (Abdel-Aty et al., 2024; Ahsan et al., 2025; Anik et al., 2024). The RTCPM models are either statistical or based on machine learning (ML) and deep learning (DL) algorithms. While statistical models provide the advantage of the interpretability the ML/DL models are best known for their enhanced prediction accuracy due to their ability to extract the underlying patterns within the data (Abdel-Aty et al., 2024). This study focuses on statistical modelling by utilizing one of the most common methods i.e. conditional logit regression to identify the traffic and weather factors associated with the likelihood of crash risk.

Conference theme
This research focuses on developing an evidence-based, proactive, weather-responsive variable speed limit (VSL) system. In this study, the "evidence" is the quantified crash risk estimated using the RTCPM model, and the "action" is the application of that risk within a weather-responsive VSL framework. Specifically, we use the estimated crash risk as a trigger to activate or deactivate the VSL system in real time based on observed traffic and weather conditions. In doing so, the research supports the ARSC2026 theme "From Evidence to Action: Shaping a Brighter Future" by translating risk estimation into operational decision-making that can improve road safety.

Method

Conditional logit regression was used to estimate how traffic and weather variables are associated with crash risk. A matched case–control design was applied to control for confounding factors such as time and location. More than two years of crash records, from July 2023 to February 2026, from a 15 km urban motorway section of the Pacific Motorway, Centenary Motorway, and Gateway Motorways in Brisbane. In total, 589 crashes in both directions were included. The reported crash times were treated as recorded reference times rather than exact timestamps. In line with previous real time crash prediction studies(Abdel-Aty et al., 2024; Zhang & Abdel-Aty, 2022), traffic conditions during the 5 to 10 minutes before the reported crash time were used to represent crash conditions. This approach reduces the effect of possible reporting uncertainty while providing extra time for proactive intervention strategies like variable speed limit (VSL) to reduce the likelihood of crash risk in next 5 to minutes. Rainfall data were obtained from the Bureau of Meteorology (BOM) radar, using a 2 km × 2 km grid with 15-minute accumulation, and were used to impute missing weather information in the crash dataset.

Traffic data, including speed, flow, and occupancy, were obtained from loop detectors at 20-second intervals. The data were cleaned to remove abnormal values, smoothed, and aggregated into 1-minute and then 5-minute bins. For each crash, upstream and downstream detectors were selected, and the 5–10 minutes before the crash time were used to represent the crash condition. Control observations were selected from incident-free days at the same location and time, matched by day of week and season, using a 1:4 crash-to-control ratio. The predictor variables included 5-minute averages, variability measures (standard deviation and coefficient of variation), and upstream-to-downstream differences in traffic variables such as speed, occupancy, and volume. Variables were selected using forward stepwise selection, and likelihood ratio tests were used to assess model improvement and remove non-significant terms.

Findings

The conditional logit regression model was applied to the abovementioned crash data using traffic variables from upstream and downstream detector pairs across three motorways. Rainfall was represented by a binary indicator for the 15-minute bin at the crash time. Traffic variables captured short term conditions using 5-minute aggregation for the period 5 to 10 minutes before the crash. The analysis included 2,945 observations in 589 matched strata, comprising 589 crash events and 2,356 non-crash events, with one case and four controls per stratum. Building on this modelling framework, the results identified a set of traffic and weather variables that were significantly associated with crash likelihood.

Among the variables retained in the final model, light rain showed a positive association with crash risk. The adjusted odds ratio for rain_light was 1.56, indicating that the presence of light rain, defined according to BOM 15-minute thresholds, increased the odds of a crash by about 56 percent compared with dry conditions, holding all other variables constant. In addition, higher downstream speed variability and higher downstream volume variability were both positively associated with crash risk, with odds ratios of 1.27 and 1.37, respectively. In contrast, upstream mean speed, upstream mean volume, and downstream mean occupancy were negatively associated with crash likelihood, with odds ratios of 0.93, 0.98, and 0.92, respectively. Taken together, these findings suggest that light rain exposure and short-term traffic conditions measured at upstream and downstream locations are associated with crash risk. All variables in the final model were statistically significant at the 95 percent confidence level. Overall model fit was good as indicated by McFadden's $\rho^2 = 0.41$, adjusted McFadden's $\rho^2 = 0.40$, AIC (1134.85), BIC (1161.13), Log Likelihood (-561.43) and Null Log Likelihood (-947.96) .

Table 1 Summary of the Conditional Logit Regression

Variable	Coeff (β)	SE	Z	P>| Z |	OR (e^{β})
upstream_mean_speed	-0.08	0.01	-13.28	0.00	0.93
upstream_mean_volume	-0.02	0.01	-2.73	0.01	0.98
downstream_mean_occupancy	-0.09	0.01	-7.77	0.00	0.92
downstream_std_speed	0.24	0.03	8.86	0.00	1.27
downstream_std_volume	0.32	0.04	7.25	0.00	1.37
rain_light	0.44	0.22	1.98	0.05	1.56

Benefits to road safety

This research has clear implications for improving road safety. First, the conditional logit regression identifies the factors associated with elevated crash risk. Second, the study supports a proactive safety strategy by enabling interventions, such as variable speed limits, to be implemented based on crash risk estimates generated by prediction models. These estimated risks can then serve as triggers for activating or deactivating variable speed limits in response to prevailing traffic and weather conditions.

Implications for policy and/or practice

The model summary from Table 1 indicates that the presence of rain has the strongest positive association with crash likelihood, alongside traffic variables that capture short-term variability and fluctuations in speed and volume. This

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supports a WVSL framework in which these traffic and weather indicators are used to estimate crash risk and trigger proactive speed limit reductions 5–10 minutes before a crash is likely to occur. By regulating speed limits based on real-time crash risk, this proactive approach can help prevent crashes and reduce trauma, while also improving motorway operations and lowering the costs associated with crash-related interventions.

Conclusions

A conditional logit regression with forward selection was used to identify key factors linked to crash risk on motorways, which can guide countermeasures to reduce crashes. This study has limitations because it relied on 15-minute aggregated radar rainfall data due to the lack of nearby roadside weather stations. Incorporating additional weather variables such as rainfall intensity, wind speed and direction, and surface friction could improve future crash risk models. Crashes were also not grouped by severity or type, so future work will use more detailed crash categories. Building on this first step, the next stage is proactive traffic management through real-time crash risk prediction and using that output to trigger a weather-responsive variable speed limit system. Since the conditional logit model was used primarily to identify significant factors rather than to predict risk, future research will focus on real-time prediction for the next 5–10 minutes using traffic, weather, and road geometry data. Recent work suggests that machine learning and deep learning can improve recall and reduce false alarms, while logistic and Bayesian models remain in useful baselines. We aim to develop a deep learning model, such as a transformer-based approach, and in parallel design a weather-responsive variable speed limit framework that uses risk estimates as guidance rather than fixed thresholds.

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From pilot to policy: scaling safe school zones in Cambodia

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Abstract
Road traffic injuries are the leading cause of death among children in Cambodia; students represent 12% of road crash fatalities. We present a Safe School Zone pilot across four secondary schools, combining Star Rating for Schools (SR4S, a 1-to-5 scale where 1 is highest risk) infrastructure assessment, road safety education for 12,788 students, and institutional strengthening. Baseline ratings ranged from 1.0 to 1.4 stars; upgrades improved one school to 1.9 stars, with modelling projecting 4.3 stars upon 30 km/h compliance. Observed speeds of 53 km/h in 30 km/h zones highlight the need for enforceable speed regulation. Knowledge gains were substantial among Grades 7-8 (1% to 97%) but lower among Grades 9-12 (0% to 39%). Safe School Zones require integrated infrastructure, education, and enforcement. The initiative embeds SR4S standards into national policy, aligning school zone upgrades with multilateral development bank investments, offering a replicable model for low- and middle-income countries.

Background
Road traffic injuries are the leading cause of death among children and youth aged 5–29 years, with over 90% of fatalities occurring in low- and middle-income countries (WHO, 2023; Tavakkoli et al., 2022). School zones represent particularly high-risk environments, as many secondary schools are situated along highways with operating speeds of 60–80 km/h, despite evidence that pedestrian fatality risk increases sharply at impact speeds above 30 km/h (WHO, 2023).

In Cambodia, students account for 12% of all road traffic deaths, with nearly 60% involving secondary and high school students (AIP Foundation & FIA Foundation, 2025). Speed non-compliance near schools is the dominant risk factor: although the Ministry of Public Works and Transportation issued guidelines in 2023 reducing school zone speed limits from 40 to 30 km/h, vehicles continue to operate well above posted limits due to weak enforcement and insufficient financing (AIP Foundation, 2023). A comparable pattern has been documented in Vietnam, where vehicle speeds near schools remain elevated despite formal policy frameworks, and motorcycle-dominated traffic sustains risk during school entry and exit periods (Dang et al., 2024). This regional consistency indicates that speed non-compliance is a structural problem requiring enforcement solutions rather than additional signage alone. Without institutional integration and sustainable financing, Safe School Zone initiatives remain fragmented and short-lived. This paper demonstrates how pilot evidence can be leveraged to inform scalable, institutionalized interventions that treat enforcement as a core requirement rather than an afterthought.

Conference theme
This paper aligns with the ARSC2026 theme, From Evidence to Action: Shaping a Brighter Future, by showing how SR4S assessments, speed observations, and knowledge evaluations produced actionable evidence that directly informed Cambodia's National Safe School Zone Guidelines and multilateral development bank investment pipelines. Critically, limitations identified in the pilot, such as absent speed enforcement and modest knowledge gains among older students, were used to refine the scaling initiative rather than being overlooked. This transparent translation of evidence into national reform provides a model for advancing child road safety in low- and middle-income countries.

Project description

Pilot Intervention (Jan 2024 - Dec 2025)
An integrated Safe School Zone model was implemented across four high schools in Siem Reap and Kampot Provinces. The intervention comprised three components. First, baseline and post-intervention infrastructure assessments using iRAP's SR4S methodology systematically identified and addressed road safety risks. Improvements included 30 km/h signage, rumble strips, traffic calming, marked crossings, and road edge delineation. Second, road safety education strengthened students' and communities' knowledge and practical skills for safe travel through school campaigns, safe riding training, and community outreach. Teachers were trained as trainers and provided with educational materials to deliver both theoretical lessons and awareness activities. Students' road safety knowledge was evaluated using structured questionnaires administered before and after the intervention. Third, Provincial Technical Working Groups were established to coordinate implementation and monitoring, with key provisions of the Road Traffic Law incorporated into school regulations. The program directly engaged 12,788 students and 406 teachers, with community outreach exceeding 34,000 individuals.

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Regional Scaling Initiative

The scaling initiative translates pilot evidence into institutional reform by embedding Safe School Zone standards within national governance frameworks and expanding implementation to additional provinces. The approach integrates multi sector coordination, formal policy endorsement, and capacity building through a training of trainers model. Co-financed infrastructure upgrades aim to achieve a minimum 3-star SR4S rating.

The USD 1.5 million investment target reflects estimated co-financing opportunities within three multilateral development bank road projects already active in the target provinces: JICA's National Road 1 rehabilitation in Kandal, ADB's Siem Reap ring road, and the World Bank's Siem Reap - Stung Treng connectivity corridor. Additional potential may emerge through JICA's Road 5 project in Battambang. This figure represents a planning estimate subject to confirmation through formal co financing negotiations. Alignment with project pipelines does not guarantee disbursement. By linking Safe School Zone guideline compliance with these existing investments, the initiative avoids the need for standalone funding and instead integrates school zone upgrades as a child safety component within larger road programs, improving implementation efficiency.

Results

Infrastructure Risk Assessment and Improvement: Baseline assessments using the iRAP SR4S methodology classified all four schools as high-risk environments, with three rated at 1.0 star and one at 1.4 stars. Following infrastructure modifications at Hun Sen Prasat Bakong High School, the rating improved from 1.0 to 1.9 stars. Modelling indicates that full compliance with the 30 km/h speed limit would increase the rating to 4.3 stars, with similar upgrade potential across the remaining three schools.
Despite these infrastructure improvements, observed operating speeds remained approximately 53 km/h within the designated 30 km/h zones. This speed differential represents the dominant residual risk factor and a critical barrier to achieving the modelled safety outcomes.

Road Safety Education: Following the intervention, the proportion of Grade 7–8 students achieving an "Excellent" road safety knowledge (above 8 on a 10-point self-administered questionnaire) rating increased from 1% to 97%, indicating that the program addressed a substantial knowledge gap at a formative stage of road use. Given the magnitude of this improvement, independent verification using a replicated assessment instrument is recommended before generalizing conclusions. Improvements among Grade 9–12 students were more modest, with the proportion achieving an "Excellent" rating increasing from 0% to 39%, although this group represents higher risk as active motorcyclists. The baseline levels of 0–1% suggest that students had limited exposure to formal road safety education prior to the intervention, reinforcing the need for structured programs to be introduced earlier in secondary schooling. It should be noted that knowledge gains do not necessarily translate into safer behavior. Future evaluations should therefore include observed road-use outcomes in addition to knowledge assessments.

Institutional Strengthening: Provincial Technical Working Groups met quarterly during the intervention and coordinated joint site inspections between transport and education officials across all four schools. Road Traffic Law provisions were formally incorporated into school regulations at each site.
However, enforcement at school perimeters remained largely absent during post intervention monitoring, indicating that institutional structures were established but not yet operationally effective. Addressing this gap requires national regulatory reform to establish enforceable zone-specific speed thresholds within the Safe School Zone framework and clearly defined accountability mechanisms for enforcement agencies.

Regional scaling began in 2025 with the establishment of a Technical Working Group on Safe School Zone Intervention and the finalization of National Safe School Zone Guidelines. Engagement with multilateral development banks has commenced in Kandal, Siem Reap, and Battambang provinces, with SR4S infrastructure upgrades planned for two pilot schools.

Benefits to road safety

This work directly reduces the risk of child pedestrian fatalities in school zones in Cambodia and provides a replicable model for low- and middle-income countries. The integrated intervention model delivers measurable and systemic benefits to child road safety. Infrastructure upgrades reduce exposure to high-speed conflict, while SR4S provides a standardized framework for prioritizing investments and tracking performance. Road safety education significantly improved students' knowledge and awareness of safe road use practices, strengthening their capacity to make safer travel decisions. Institutional capacity enhancements improve coordination across transport and education authorities and formalize school zone safety standards within governance structures.

Implications for policy and/or practice

The pilot confirms that combining infrastructure improvements with enforcement reduces risk more effectively than signage alone. Observed vehicle speeds of 53 kilometers per hour in 30 kilometers per hour zones indicate that signage without enforcement produces minimal behavioral change. National Safe School Zone policy should require integrated

interventions that combine traffic calming, enforcement, and SR4S monitoring to ensure consistent evaluation and evidence-based investment.

Road safety education should be tailored by age. Limited gains among students in Grades 9–12 show that current methods are insufficient for older, higher-risk road users. Programs should emphasize peer-led and scenario-based learning approaches suitable for this age group and measure behavioral outcomes rather than knowledge scores alone as the primary indicator of success.

Conclusions

Safe School Zone interventions demonstrate measurable improvements in infrastructure risk indicators, student safety knowledge, and institutional capacity. However, sustained risk reduction depends on two conditions the pilot revealed as unmet: consistent speed enforcement and clear institutional accountability for that enforcement.

The pilot provides empirical evidence of what an integrated model can achieve. The regional scaling initiative translates this evidence, including its limitations, into national policy instruments, regulatory standards, and structured investment pipelines. Critically, evidence of what did not work is as instructive as evidence of what did, and both should inform the design of scalable national programs.

Cambodia's integration of the SR4S methodology and 30 km/h speed principles within national governance and multilateral development bank financing frameworks offers a replicable model for other low- and middle-income countries seeking to move beyond isolated pilots toward institutionalized school zone safety reform.

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