

# **Proceedings of the 2021 Australasian Road Safety Conference**

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## **Preface**

Welcome to the 2021 Australasian Road Safety Conference.

After postponing the 2020 conference by a year due to the COVID-19 pandemic, we are pleased to present the proceedings for the first fully virtual format for this conference. This is the sixth conference in the series that commenced with amalgamation of the Road Safety Research and Education Conference and the Australasian College of Road Safety Conference. This conference is a unique opportunity for everyone involved in road safety including researchers, practitioners, policymakers, police, educators, advocates and community groups to meet, present and discuss their work.

These proceedings describe research, educational and policing program implementation and policy and management strategies related to all aspects of road safety and especially related to the conference theme of Towards Zero: A Fresh Approach.

This year's conference covers a comprehensive range of topics including speed, infrastructure and road design, education, licensing, vehicle design, impairment due to alcohol, drugs and mobile phones. The conference also presents innovative symposium sessions including interdisciplinary approaches combining safety, the law and design and showcasing successful programs involving at-risk youth, older drivers and safety approaches for non-occupants, specifically when we walk and ride a bicycle. Around 600 delegates from 28 countries will be attending the on-line virtual conference.

Authors of accepted Extended Abstracts and Full Papers represent international and local institutions from all aspects of their respective communities including research centres, private companies, government agencies and community groups. These Extended Abstracts provide an indication of the important work being done in Australia, New Zealand and internationally as part of the United Nations, One UN Vision for Road Safety to reduce the number of crashes on the road by 50 percent by 2030.

The Conference Organising Committee allowed two manuscript types for the conference: 'Extended Abstracts' and peer-reviewed 'Full Papers'. Using a similar format to the previous successful conference in 2019, the Conference Scientific sub-Committee initially called for submissions in the form of Extended Abstracts (approx. 1 to 3 pages). Groups of submissions around similar themes were assigned to Conference Handling Editors with senior peer status in the respective field of road safety, who then handled the review process for their assigned submissions. Each Extended Abstract was reviewed by two independent expert peer reviewers on the following selection criteria: content consistent with the conference theme, novelty of information or data, clarity, relevance to practice or policy, scientific merit, and interest to audience. The Conference International sub-Committee also assisted with the review of Lower and Middle Income Country (LMIC) submissions and also allocating LMIC mentors for those authors

requesting assistance with their submission. A total of 182 Extended Abstract manuscripts from 245 submissions were accepted as Extended Abstracts.

Authors were also provided the option of submitting a Full Paper, which is HERDC\* compliant. Based on the outcome of the peer review of their Extended Abstract, some authors who requested extension of their submissions into Full Papers for a run on into the Journal of Road Safety, were provided that opportunity by the two peer reviewers. The submitted Full Paper subsequently underwent a further review by three independent (new) peer reviewers for inclusion into the Journal of Road Safety. There were seventeen Full Paper submissions of which four have so far been fully peer-reviewed and accepted for publication in the Journal.

For the first time in the conference series the ACRS2021 partnered with Monash University's Monash Art, Design and Architecture (MADA) this year to link Poster authors with final year graphic design students and alumni. This gave authors an opportunity to develop high quality visual communications of their poster content. The eight Authors who chose this option that were matched with a MADA graphic design student and successfully completed the Poster, have had their Poster attached to their Extended Abstract pdfs in these Proceedings. The Poster authors were also provided a 5 minute oral Poster presentation slot in one of the conference program parallel sessions.

An additional incentive to provide potential authors from Lower and Middle Income Countries (LMICs) an opportunity to submit an Extended Abstract and attend the conference, was the establishment of a LMIC Scholarship provided by the Department of Infrastructure, Transport, Regional Development and Communications. The scholarships assisted LMIC presenter delegates with covering their registration fee. Scholarships were allocated to authors of 14 Extended Abstract submissions across 9 countries – Afghanistan, Bangladesh, Cambodia, India, Iran, Malaysia, Myanmar, Thailand and Uganda.

Putting together such a high-quality program requires a contribution from many people. We thank the Conference Handling Editors for taking the time to handle submissions, allocate appropriate reviewers, and provide useful and constructive feedback to authors. Likewise, we are grateful to our road safety peers for their help in reviewing 245 Extended Abstract submissions. The high calibre of the conference proceedings is only achieved with their assistance and we thank them all for contributing their valuable time. We also warmly thank all the keynote speakers, symposium organisers and presenters, the Conference Organising Committee, the Scientific sub-Committee, the International sub-Committee, the Social Activity sub-Committee, the Sponsorship sub-Committee, the conference sponsors, and the session Chairs. The valuable input and enthusiasm from each person and group has helped to ensure the 2021 Australasian Road Safety Conference meets the needs of the diverse range of participants and contributes to the overall success of the event. Most importantly, we trust that the work described in these proceedings Extended Abstracts and the Full Papers that will be published in the Journal of Road Safety\*\*, will contribute to the reduction in road trauma in Australia, New Zealand and internationally.

These proceedings include the list of the: conference committees and members; Conference Handling Editors; Peer-Reviewers; a copy of the conference program; and, a list of all the Extended Abstracts. All Extended Abstract will be available post conference on the Australasian College of Road Safety publication search engine\*\*\*.

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\* <https://www.education.gov.au/higher-education-research-data-collection>

\*\* <https://acrs.org.au/journals/>

\*\*\* <https://acrs.org.au/publications/>

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### CONFERENCE PROGRAM

*This draft program is subject to change.  
All times are Australian Eastern Standard Time (AEST)*

	<b>Monday, 27 September 2021</b> Conference Pre-Day
	Pre-Conference Meetings/Events
2:30-4:00pm	Early Career Professionals Event
4:00-5:30pm	ACRS International Outreach Chapter (IOC) Event

	<b>Tuesday, 28 September 2021</b>
8:30-9:10am	<p style="text-align: center;"><b>Opening Plenary Session</b> Chair: <b>Mr Chris Brennan</b>, Manager Road Safety Strategy &amp; Data, Road Safety Victoria, Department of Transport</p> <p style="text-align: center;"><b>Welcome to Country</b>, Wurundjeri Woi-wurrung Cultural Heritage Aboriginal Corporation <b>Hon Ben Carroll MP</b>, Minister for Public Transport and Minister for Roads and Road Safety <b>Dr Ingrid Johnston</b>, CEO, Australasian College of Road Safety <b>Dr Geoff Allan</b>, CEO, Austroads</p>
9:00-10:30am	<p style="text-align: center;"><b>Plenary 1</b> <b>Doing road safety differently – what needs to change?</b> Chair: <b>Dr Marilyn Johnson</b>, Senior Researcher, Institute of Transport Studies, Monash University</p> <p style="text-align: center;"><b>Ms Maria Fernanda Rodriguez Bongoll</b>, President of the Board, Fundacion Gonzalo Rodriguez <b>Dr Soames Job</b>, CEO and Principal, Global Road Safety Solutions Pty. Ltd.</p> <p style="text-align: center;">Followed by a panel discussion between all Plenary 1 speakers</p>
10:30-11:00am	<b>Morning Tea, Exhibition + Open networking</b>

Concurrent Sessions 1						
Topic	Road audit/assessment	Crash data analysis 1	Older road users, caravans and buses	Licensing and Young drivers	Education	Motorcycle riders
11:00-11:15	7 <b>John Poynton</b> Safe System Solutions Pty Ltd <i>A safe access audit tool for active transport</i>	224 <b>Chris Stokes</b> The University of Adelaide <i>Using in-depth accident data to identify limitations when applying crash injury risk curves</i>	158 <b>Marilyn Di Stefano</b> Road Safety Victoria Department of Transport <i>Medical Fitness to Drive: Development of Transport and Medical Practitioner partnership to enhance road safety</i>	100 <b>Prasannah Prabhakaran</b> University of New South Wales <i>Assessing the Ecological Validity of Button-Press Hazard Perception Tests</i>	244 <b>Nicole Downing</b> Department of Transport and Main Roads <i>An omnichannel approach: Queensland's Road Safety Education Blueprint for Children and Youth</i>	77 <b>Lucy Filardo and Teresa Senserrick</b> Centre for Road Safety and CARRS-Q, QUT <i>Evaluation of the NSW Motorcycle Graduated Licensing Scheme</i>
11:15-11:30	150 <b>Robyn Gardener</b> Fulton Hogan Ltd <i>Developing a Geo Artificial Intelligence Process to Assist with Programme Evaluation</i>	120 <b>Laurie Budd</b> Monash University Accident Research Centre (MUARC) <i>Future Light Vehicle Safety Priority Areas in Australia</i>	168 <b>Rebecca McLean</b> University of Otago Dunedin School of Medicine <i>Screening older drivers: The experiences of General Practitioners with medical fitness to drive assessments</i>	94 <b>Natalie Watson-Brown</b> CARRS-Q, QUT <i>Bad habits while racing to the starting line: Obstacles to the development of young Learner's safe driving practices</i>	119 <b>Louise Cosgrove</b> Macquarie University - Kids and Traffic <i>Responsivity and innovation in road safety education: are we listening to our audience?</i>	247 <b>Luke Pugsley</b> Department of Transport and Main Roads <i>Motorcyclist personas: it's not one size fits all</i>
11:30-11:45	65 <b>Kenn Beer</b> Safe System Solutions Pty Ltd <i>Roads That Cars Can Read assessment: Practical Applications in NSW</i>	157 <b>Murtaza Sultani</b> Land Transport Authority <i>Developing a Black Spot Investigation Program for Kabul city Roads</i>	135 <b>Mohd Naguib Mohd Yunus</b> Flinders Medical Centre <i>Agreement on fitness to drive outcome between rehabilitation medicine physician prediction and occupational therapy on-road assessment</i>	246 <b>Nicole Downing</b> Department of Transport and Main Roads <i>Reviewing Queensland's Indigenous Driver Licensing Program</i>	19 <b>Catharine Hydon</b> Early Learning Association Australia <i>Active and Safe: Young children as engaged road users in their communities</i>	153 <b>Angelo Lambrinos</b> Transurban <i>Transurban Queensland Motorbike Incident Response Trial</i>
11:45-12:00	49 <b>Kenn Beer</b> Safe System Solutions Pty Ltd <i>Road Safety Capability Requirements for Road Authorities</i>	125 <b>Venkatesh Balasubramanian</b> IIT Madras <i>Epidemiology and Injury Profiles of Single Vehicle Motorcycle Fatalities in Tamil Nadu, India, 2009-2017</i>	164 <b>Marilyn Di Stefano</b> Road Safety Victoria Department of Transport <i>Motorised mobility device use: consensus based non-regulatory countermeasures to enhance user road safety</i>	221 <b>Lisa Sharwood</b> The University of Sydney <i>Can I have your attention please? Piloting an outcome evaluation on pre-novice driving youth aiming to determine the 'bstreetsmart' impact</i>	51 <b>Oleksandra Molloy</b> University of New South Wales <i>The impact of the medium in which feedback is presented on young drivers' speed management behaviour</i>	200 <b>Paul Graham</b> New Zealand Transport Agency <i>Motorcycling – unsafe, but legitimate form of transport</i>
12:00-12:15		95 <b>Ralston Fernandes and Johan Standroth</b> Centre for Road Safety and Transport for NSW <i>Case-By-Case Analysis of Current Fatality Trends to Estimate Future Residual Trauma in NSW</i>	160 <b>Carl Liersch</b> APV-T <i>Bus passenger protection – are we there yet? After 30 years what are the new challenges to bus safety.</i>	25 <b>Brad Crofts / Georgia Symmons</b> Fit to Drive Foundation <i>LET'S #GOSAFELY A community-based multi stakeholder approach to road safety education for young adult road users</i>	115 <b>Chris Stokes</b> The University of Adelaide <i>Safe System for Universities: education for tertiary engineering students update</i>	166 <b>Siya Aggrey</b> Makerere University College of Health Sciences <i>Perceived factors associated with boda-boda (motorcycle) accidents in Kampala, Uganda</i>
POSTERS						
12:15-12:20	42 <b>Fritha Argus</b> Main Roads Western Australia <i>Using road inventory data to produce AusRAP star ratings</i>	34 <b>Mohammad Ibrahim</b> Monash University Accident Research Centre (MUARC) <i>Using relative risk of different travel options as part of journey planning attributes – a case study from Victoria</i>	75 <b>Ranmalee Eramudugolla</b> Neuroscience Research Australia <i>On-road driving errors in Mild Cognitive Impairment</i>	142 <b>Juliet Bartels</b> Road Safety Victoria Department of Transport <i>Supervised practice hours among older novice drivers in Victoria: Stakeholder perceptions and readiness to obtain supervised driving practice</i>	211 <b>Phillip Mallis</b> City of Darebin <i>Darebin's Octopus School Pilot Program</i>	156 <b>Ross Blackman</b> Queensland University of Technology <i>Motorcycle choice and self-reported crashes of Queensland motorcyclists</i>
12:20-12:25		57 <b>Richard Cohan</b> Transport for New South Wales <i>The next frontier: Road safety in the workplace</i>	23 <b>Jennifer Felsch</b> Transport for New South Wales <i>Caravan Safety Awareness Project in northern NSW</i>			
12:25-12:30	<b>Marilyn Johnson and Robbie Napper</b> ARSC2021 and Monash University Poster collaboration					
12:30-12:40pm	Post session networking	Post session networking	Post session networking	Post session networking	Post session networking	Post session networking
12:40-1:30pm	Lunch, Exhibition					

Concurrent Sessions 2						
Topic	Pedestrians	Crash data analysis 2	Enforcement and Policing 1	Young drivers	Symposium 1	Symposium 2
1:30-1:45pm	233 <b>Joseph Le</b> Transport for NSW  <i>Development and Delivery of the Pedestrian Protection at Signalised Intersection Mass Action Program</i>	140 <b>Denny Meyer</b> Swinburne University of Technology  <i>Modelling the Relationship Between Driver History and Crash Risk</i>	167 <b>Kelly Imberger</b> Road Safety Victoria Department of Transport  <i>Offence and Crash Involvement of High-Frequency, High-Risk Offenders</i>	Mini symposium  TAC L2P program, enhanced program including youth at high risk (e.g. criminal justice system, homelessness)  <b>Patrice Smith</b> City of Casey  Paul Moore Road Safety Victoria Department of Transport  Sunera Patabendige City of Casey  Patrice Smith City of Casey	<b>Achieving speed management in the Eastern Mediterranean Region</b>  <b>Lori Mooren</b>  Eng. Hormoz Zakeri National Road Safety Commission, Iran  Mohammad Mehdi Besharati Iran University of Science and Technology  Mohsen Fallah Zavareh Kharazmi University  Mohsen Shams Yasuj University of Medical Sciences  <b>Panelists</b>  Mansour Ranjbar World Health Organisation, Tehran  Christoph Hamlemann WHO representative  Ali Tavakoli Kashani Iran University of Science and Technology  Eng. Javad Hedayati Road Maintenance and Transportation Organization  Hassan Abdoss Road Maintenance and Transportation Organization	<b>Creating opportunity for people who can't access safe mobility and making it a reality</b>  <b>Jerome Carslake</b> National Road Safety Partnership Program (NRSP)  Tristan King Empowr Mobility  Binyam Tekeie Young driver  Naheed Akhtar Laverton Community Education Centre  Anthony Cavanagh Ganbina
1:45-2:00pm	151 <b>Juliet Bartels</b> Road Safety Victoria Department of Transport  <i>Pedestrian Road Safety Project</i>	209 <b>Paul Graham</b> New Zealand Transport Agency  <i>Estimating the effect of multiple combined interventions: the IILM</i>	20 <b>Jenelle Hardiman</b> Victoria Police  <i>Comparison of Skidding Vehicle Drag Factors on Various Surfaces</i>			
2:00-2:15pm	39 <b>Gregoire Larue</b> CARRS-Q, QUT  <i>Increasing awareness of distracted pedestrians at railway level crossings with illuminated in-ground lights</i>	28 <b>Asif Hassan</b> Transport for NSW  <i>A Structural Equation Model for Pedestrian Crashes in Sydney</i>	169 <b>Kelly Imberger</b> Road Safety Victoria Department of Transport  <i>Effectiveness of Vehicle Impoundment for Victorian High Level Speeders</i>			
2:15-2:30pm	78 <b>Michael Regan</b> University of New South Wales  <i>The Relationship between Pedestrian Waiting Times and Illegal Crossing Behaviours at Signalised Intersections in the Sydney CBD</i>	126 <b>Venkatesh Balasubramania</b> IIT Madras  <i>Analysis of Injury Severity in Single-Vehicle Four-Wheeler Crashes with drivers being at-fault in Tamil Nadu, India</i>	17 <b>Max Cameron</b> Monash University Accident Research Centre (MUARC)  <i>Increasing the effectiveness of mobile speed cameras on rural roads in Victoria based on crash reductions from operations in Queensland</i>	16 <b>Lyndel Bates</b> Griffith University  <i>The Effect of Parenting Styles and Differing Theoretical Frameworks on Young Drivers Self-Reported Compliance</i>		
2:30-2:45pm	58 and 148 <b>Joanne Wood</b> QUT  <i>Making nighttime pedestrians safer using innovative clothing designs</i>	225 <b>Gregoire Larue</b> CARRS-Q  <i>Crashes Classification in Naturalistic Driving Scenarios Using Random Forest Machine Learning Algorithm</i>	198 <b>Christopher Poulter</b> Road Safety Victoria Department of Transport  <i>Investigating driver compliance with Road Rule 79A in Victoria</i>	43 <b>Guneet Singh Assi</b> Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh  <i>Self perception, driving patterns and gender differences on psychological measures of young Indian drivers</i>		
2:45-3:00pm		107 <b>David Chircop</b> Transport for NSW  <i>Analysis of rear-end and other crashes related to roadwork sites in NSW</i>	2119 <b>Laura Mills</b> University of the Sunshine Coast  <i>Twelve Years of Roadside Drug Testing in Queensland: The Extent and Nature of Recidivism</i>	76 <b>Joanne Bennett</b> Australian Catholic University  <i>Cognitive Function and Driving Performance for Young Drivers: A Systematic Review and Meta-Analysis</i>		
3:00-3:10pm	Post session networking	Post session networking	Post session networking	Post session networking		
3:10-3:30pm	<b>Afternoon Tea, Exhibition</b>					
3:30-5:00pm	<b>Plenary 2</b> <b>Managing road safety within complex systems</b> Chair: <b>Professor Narelle Haworth AM</b> , Faculty of Health, School of Psychology & Counselling, CARRS-Q  <b>Mr Michael Nieuwesteeg</b> , Program Manager for Road Safety and Design, Austroads <b>Ms Gabby O'Neill</b> , Head, Office of Road Safety <b>Dr Nhan Trann</b> , Head, Safety and Mobility, World Health Organization  Followed by a panel discussion between all plenary 2 speakers plus <b>Mr Martin Small</b> , President, Australasian College of Road Safety					

Wednesday, 29 September 2021						
8:30-10:30am	<p align="center"><b>Plenary 3</b>  <b>Will technology save us?</b>  Chair: <b>Mr Kenn Beer</b>, Principal Engineer, Safe System Solutions Pty Ltd</p> <p align="center"><b>Dr Mike Lenné</b>, Chief of Human Factors &amp; Safety, Seeing Machines  <b>Dr Bud Zaouk</b>, Founder and CEO of Kea Technologies and the DADSS Program, DADDS  <b>Ms Maree Bridger</b>, FAS Surface Transport Policy, Office of Road Safety  <b>Ms Carla Hoorweg</b>, CEO, ANCAP</p> <p align="center">Followed by a panel discussion between all plenary 3 speakers plus <b>Emeritus Professor Ann Williamson</b>, Transport and Road Safety Research Centre, School of Aviation, The University of New South Wales</p>					
10:30-11:00am	<p align="center"><b>Morning Tea, Exhibition, Poster Gallery</b></p>					
	<p align="center"><b>Concurrent Sessions 3</b></p>					
Topic	<b>Evaluations</b>	<b>Seat belts and child restraints</b>	<b>Speed 1</b>	<b>Heavy vehicles</b>	<b>Symposium 3</b>	<b>Symposium 4</b>
11:00-11:15am	21-20 <b>Amanda Pushka</b> MicroTraffic Inc. Winnipeg, Manitoba  <i>Comprehensive Safety Assessments and Rapid Evaluations Using Video Analytics and Conflict Data: Innovative Approaches from North America</i>	72 <b>Tom Whyte</b> Neuroscience Research Australia  <i>Side impact intrusion in child passenger deaths and the performance of child restraint systems</i>	24 <b>David Soole</b> Department of Transport Main Roads Queensland  <i>The attribution of casualty crashes to low-level speeding in Queensland</i>	74 <b>Jerome Carslake</b> National Road Safety Partnership Program (NRSPP)  <i>Construction Logistics and Community Safety Australia (CLOCS-A): Progress Towards Safer Outcomes for Vulnerable Road Users</i>	<b>Event data recorders</b>  <b>Sam Doecke</b> The University of Adelaide Centre for Automotive Safety Research  <i>Event data recorders in cars, an introduction</i>	<b>How can road safety strategies increase safety for all road users?</b>  <b>Sam Bolton</b> Cycling and Walking Australia and New Zealand (CWANZ)  <b>Sara Stace</b> WSP  <b>Stephen Hodge</b> We Ride Australia  <b>Ben Rossiter</b> Victoria Walks  <b>Craig Hoey</b> Department of State Growth, Tasmania  <b>Craig Wooldridge</b> Main Roads Western Australia  <b>Marilyn Johnson</b> Monash University
11:15-11:30am	21-26 <b>Shane Turner</b> Abley Limited  <i>Developing Safe System Projects and Programs using Safety Science Methods</i>	48 <b>Inam Ahmad</b> Monash University Accident Research Centre (MUARC)  <i>Findings on child restraint system (CRS) use in Dubai, United Arab Emirates</i>	37 <b>Paul Roberts</b> The University of Western Australia  <i>Impact of a Rural Intersection Active Warning System (RIAWS) on Driver Speed: A Driving Simulator Study</i>	207 <b>Michael Chan</b> Department of Transport  <i>Developing a heavy vehicles safety features roadmap in order to promote safer heavy vehicles beyond the basic legal requirements</i>	<b>Martin Elsegood</b> The University of Adelaide Centre for Automotive Safety Research  <i>Speeding insights from the CASR EDR Study</i>	
11:30-11:45am	21-23 <b>David Silvester</b> BECA Pty Ltd Melbourne, Victoria  <i>The Effectiveness of the Safer Roads Infrastructure Program Stage 3 (SRIP3)</i>	238 <b>George Rechnitzer</b> Victorian Institute of Forensic Medicine, George Rechnitzer & Associates Pty Ltd, UNSW  <i>The "unseen passenger": current vehicle restraint systems are not designed for safety of pregnant women and their fetus</i>	40 <b>Chamila Kariyawasam</b> Main Roads Western Australia  <i>Road safety gains from small speed reduction wheatbelt roads in rural WA</i>	180 <b>Stuart Wade</b> Transurban  <i>Road Safety Innovation for Heavy Truck Movements Across Structures</i>	<b>Michael Hardiman</b> Victoria Police  <i>Real world application of event data recorders</i>	
11:45am-12:00pm	21-22 <b>Shane Turner</b> Abley Limited  <i>Improving the Evaluation of Victoria's Road Safety Program</i>	185 <b>Paulette Ziekemijer</b> Transport Accident Commission  <i>Injury prevention hot-topics: trauma associated with seatbelt non-use and ute occupants</i>	109 <b>Teresa Senserrick</b> CARRS-Q, QUT  <i>Young Novice Drivers' Speed Management: a systematic review</i>	127 <b>Venkatesh Balasubramania</b> IIT Madras  <i>Investigation of Injury patterns in Heavy-duty Single Vehicle crashes based on real-world accident data in Tamilnadu, India</i>	<b>Giulio Ponte</b> The University of Adelaide Centre for Automotive Safety Research  <i>Advanced automotive crash notification systems and EDRs</i>	
12:00-12:15pm	21-24 <b>Suzanne Walker</b> GHD Pty Ltd  <i>Safer Roads Black Audio Tactile Linemarking Short Term Evaluation</i>	223 <b>Bianca Albanese</b> Neuroscience Research Australia  <i>Can specific child restraint design features improve correct use?</i>	182 <b>Jodi Page-Smith</b> Transport Accident Commission  <i>Country Driver Behaviour</i>	202 <b>Michael Mortimer</b> Deakin University  <i>Using Virtual Reality to Increase Awareness on Safe Interactions between Light and Heavy Vehicles</i>		
12:15-12:30pm	101 <b>Mario Mongiardini</b> The University of Adelaide  <i>Evaluation of a warning system to reduce the risk of casualty crashes at rural junctions in South Australia</i>	2147 <b>Helen Lindner</b> Mobility and Accessibility for Children in Australia (MACA)  <i>Safety for all: building an evidence base to support safe vehicle transport for children with disabilities and medical conditions</i>	68 <b>Donal McGrane</b> ANCAP  <i>ANCAP Speed Limit Information Function Assessment</i>	220 <b>Daniel Brain</b> Toll Group  <i>Consignors of import containers play a critical role in preventing heavy vehicle rollover, but they're often unaware of their role</i>		
12:30-12:40pm	Post session networking	Post session networking	Post session networking	Post session networking		
12:40-1:30pm	<p align="center"><b>Lunch, Exhibition, Poster Gallery</b></p>					

Concurrent Sessions 4						
Topic	Intelligent transport systems	Connected and Automated Vehicles (CAV)	Speed 2	Safe System	Symposium 5	Symposium 6
1:30-1:45pm	104 <b>Oliver Storey</b> Transport for New South Wales  <i>A methodological approach to reducing connected vehicle data</i>	204 <b>Joanne Vanselow</b> Department of Transport  <i>Towards Zero CAV Trial Grants Program – identifying road safety actions through public-private collaboration</i>	21-21 <b>Lisa Steinmetz</b> O'Brien Traffic  <i>Implementation and evaluation of Area 40 in Maribyrnong – findings and lessons to date</i>	192 <b>Elizabeth Waller</b> Transurban  <i>Safe system capability development in the context of industry</i>	<b>Partnerships Multiply Outcomes - Successes and Opportunities in Local Government and Community Road Safety</b>  <b>Mayor Matthew Burnett</b> Gladstone Regional Council (GRC) and Australian Local Government Association (ALGA) Director & Vice President  82 <b>Michelle McLaughlin</b> Little Blue Dinosaur Foundation  <i>Little Blue Dinosaur Foundation – Our Story – Prevention through Collaboration with Community Road Safety Stakeholders</i>  98 <b>Tracey Norberg</b> Goulburn Mulwaree Council  <i>Towards Zero, a community approach to helping learner drivers and senior drivers, our vulnerable road users</i>  52 <b>Kate McDougall</b> Eurobodalla Shire Council  <i>Driving Safer Rural Roads – A systematic safe systems review of a local government rural road network</i>  123 <b>Joanne Wilson-Ridley</b> Queanbeyan-Palerang Regional Council  <i>Joe Rider Motorcycle Safety Project - Cross border road safety cooperation and implementation into local government regions</i>	<b>Design, the Law and Lego® an interdisciplinary approach to road safety</b>  <b>NOTE</b> Virtual delegates: Please bring your Lego® to this Symposium  <b>Robbie Napper</b> Monash University  <b>Vanessa Johnston</b> RMIT University
1:45-2.00pm	56 <b>Kerry Shaz</b> Transport for NSW  <i>The CITI Connected Light Vehicle Study: Lessons Learnt</i>	195 <b>Joanne Vanselow</b> Department of Transport  <i>Department of Transport and Bosch CAV Highway Pilot Trial on Victorian Rural Roads</i>	92 <b>Jamie Mackenzie</b> The University of Adelaide  <i>A technical review of 40 km/h speed limits in the City of Charles Sturt Local Government Area</i>	61 <b>John Gaffney and Elizabeth Hovenden</b> Department of Transport (Victoria)  <i>Can I Stop? Considering any opportunity to influence the multidisciplinary factors that result in a crash</i>		
2:00-2.15pm	174 <b>Toby Cooper</b> GHD Pty Ltd  <i>Traffic Analysis – AI from a bird's eye view</i>	194 <b>Andry Rakotonirainy</b> CARRS-Q, QUT  <i>Demystifying the Automated Vehicle trolley problem</i>	245 <b>Ray Shuey</b> Strategic Safety Solutions  <i>Speed management in Iran</i>	226 <b>Chris Jurewicz</b> Transport Accident Commission  <i>Safe System Infrastructure Innovation in Victoria's Safer Roads Program</i>		
2:15-2.30pm	203 <b>Mohammed Elhenawy</b> CARRS-Q, QUT  <i>Detecting Road User Mode of Transportation using Deep Learning to Enhance VRU Safety in the C-ITS Environment</i>	196 <b>James Soo</b> Department of Transport  <i>Exploring the safety potential of cellular-V2X based vehicle connectivity, results from the advanced connected vehicles Victoria trial</i>	80 <b>Kerkritt Sriroongvikrai</b> Chulalongkorn University Faculty of Engineering  <i>Impacts of speed limit changes on road safety risks: A cases study of urban streets in Thailand</i>	201 <b>Wayne Moon</b> Road Safety Victoria  <i>A Modernised Safe System Model</i>		
2:30-2.45pm	114 <b>Matthew Howe</b> The University of Adelaide Centre for Automotive Safety Research  <i>What computer vision can tell us about road safety?</i>	190 <b>Katie Minogue</b> Maurice Blackburn Lawyers  <i>When The Rubber Hits The Road - Australia's Motor Accident Injury Insurance Schemes And Autonomous Vehicles</i>	178 <b>Mario Mongiardini</b> The University of Adelaide  <i>Evaluate travel speeds and associated risk of casualty crashes through intersections in Australia using naturalistic driving data</i>	236 <b>Sarah Morris</b> Department of Transport  <i>Safer Roads Program Staged Development Process</i>		
2:45-3.00pm	152 <b>Rowena Lamond</b> Origin Energy  <i>Assessment of CSG Operator driving related transport incidents and impact of implementing IVMS on incident frequency</i>	197 <b>Andrew Somers</b> Omni-Aware  <i>Adapting AV perception for safer roads, results from the Omni-Aware trial project</i>	215 <b>Mohammad Mahbub Alam Talukder</b> Accident Research Institute, BUET  <i>Over Speeding and Road Safety in Bangladesh</i>	6 <b>Robert Morgan</b> Traffic Engineering and Road Safety Consultant  <i>Paradigm Lost – Getting Beyond the Safe System</i>		
3:00-3:10pm	Post session networking	Post session networking	Post session networking	Post session networking		
3:10-3.30pm	<b>Afternoon Tea, Exhibition, Poster Gallery</b>					
3:30-5:30pm	<b>Plenary 4</b> <b>Translating research into practice: workplace road safety</b> Chair: <b>Dr Raphael Grzebieta</b> , Transport & Road Safety Research (TARS) Research Centre, UNSW Victorian Institute of Forensic Medicine, Monash University  <b>Associate Professor Sharon Newnam</b> , Associate Director, Systems Safety Team, Monash University Accident Research Centre (MUARC) <b>Mr Jerome Carslake</b> , Director, National Road Safety Partnership Program (NRSPP) <b>Mr Daniel Brain</b> , Load Restraint Specialist, Toll Group <b>Mr Paul Harrison</b> , Principal Advisor Work Related Road Safety at Waka Kotahi, New Zealand Transport Agency  Followed by a panel discussion between all plenary 4 speakers					
5:30-6:30pm	<b>AWARDS CEREMONY</b> Mr Martin Small, ACRS President DPM, TBC Dr Tana Tan, Young Leader Oration 3M Diamond Road Safety Award ACRS Fellow					

Thursday, 30 September 2021						
9:00-10:30am	<p align="center"><b>Plenary 5</b>  <b>Systems thinking for future road safety (Zero by 2050)</b>  <b>Chair: Mr Carl Muller</b>, Executive Director, Road Safety Victoria</p> <p align="center"><b>Professor Paul Salmon</b>, Director, Centre for Human Factors and Sociotechnical Systems, University of the Sunshine Coast  <b>Dr Brett Hughes</b>, Principal, P7Safety  <b>Ms Samantha Cockfield</b>, Head of Road Safety, TAC</p> <p align="center">Followed by a panel discussion between all plenary 5 speakers plus <b>Mr Martin Small</b>, President, Australasian College of Road Safety and <b>Professor Narelle Haworth AM</b>, Faculty of Health, School of Psychology &amp; Counselling, CARRS-Q</p>					
10:30-11:00am	Morning tea, Exhibition, Poster Gallery					
Concurrent Sessions 5						
Topic	Health	Crash data analysis 3	Cyclists and scooters	Roads and roadsides	Vehicle technology	Enforcement and Policing 2
11:00-11:15am	<p align="center">64 <b>Roisin Sweeney</b> Injury Matters</p> <p><i>Development of a truck driver public health project: mental and physical safety (MaPS) on our roads</i></p>	<p align="center">86 <b>Giulio Ponte</b> The University of Adelaide Centre for Automotive and Safety Research</p> <p><i>Injury risk and delta-V - insights from event data recorder information and reported injury outcomes</i></p>	<p align="center">32 <b>Anthony Aisenberg</b> CrowdSpot Pty Ltd</p> <p><i>BikeSpot 2020 – Crowd mapping cycling stress across Victoria</i></p>	<p align="center">8 <b>Tana Tan</b> Safe System Solutions Pty Ltd</p> <p><i>Audio-tactile Line-marking and Motorcycle Stability - A Pilot Study</i></p>	<p align="center">36 <b>Giovanni Savino</b> University of Florence</p> <p><i>The acceptance of Autonomous emergency braking system for motorcycles: results before and after testing</i></p>	<p align="center">184 <b>Verity Truelove</b> University of the Sunshine Coast</p> <p><i>A Mixed-Methods Study Examining the Impact of Legal Enforcement on Concealed Phone Use while Driving</i></p>
11:15-11:30am	<p align="center">55 <b>Alyson Elari</b> Injury Matters</p> <p><i>Road trauma support WA: using a public health approach to reduce the long term effects of road trauma</i></p>	<p align="center">21-32 <b>Priyank Trivedi</b> IITRAM: Institute of Infrastructure Technology Research and Management</p> <p><i>Identification of road accidents severity ranking by integrating the Multi-Criteria Decision Making approach</i></p>	<p align="center">141 <b>Jake Olivier</b> University of New South Wales</p> <p><i>Does Biomechanical and Epidemiological Evidence of Bicycle Helmet Effectiveness Translate to a Population?</i></p>	<p align="center">81 <b>Colin Brodie</b> New Zealand Transport Agency</p> <p><i>Understanding the Safety Impacts and Opportunities of New Zealand State Highway Resurfacing and Renewals</i></p>	<p align="center">105 <b>Christine Mulvihill</b> Monash University Accident Research Centre (MUARC)</p> <p><i>Evaluation of a prototype driver distraction human-machine interface warning system</i></p>	<p align="center">106 <b>Michael Timms</b> NSW Police Force</p> <p><i>Safety Testing of Police Motorcycle Jackets</i></p>
11:30-11:45am	<p align="center">70 <b>Siobhan O'Donovan</b> The University of Adelaide</p> <p><i>Cardiac disease and driver fatality</i></p>	<p align="center">84 <b>David McTiernan</b> ARRB</p> <p><i>Safe System Review of Fatal Crashes in the ACT</i></p>	<p align="center">177 <b>Amanda Reynolds</b> Transport Accident Commission</p> <p><i>E-Scooters – are they last mile solution or the last mile health problem?</i></p>	<p align="center">118 <b>David Chircop</b> Transport for New South Wales</p> <p><i>Evaluation of yellow line marking and variable speed limit signs to improve safety in roadwork zones in NSW</i></p>	<p align="center">90 <b>Martin Elsegood</b> Centre for Automotive Safety Research</p> <p><i>Determining the readiness of road line markings for autonomous vehicles through custom video analysis software</i></p>	<p align="center"><b>Speed 3</b> 3 <b>Timothy Clark</b> Transurban</p> <p><i>M7 to M2 Pre-congestion Speed Management</i></p>
11:45-12:00am	<p align="center">172 <b>Ying Ru Feng</b> The University of Western Australia</p> <p><i>Changes in Driving Performance after First and Second Eye Cataract Surgery: A Driving Simulator Study</i></p>	<p align="center">53 <b>Asif Hassan</b> Transport for NSW</p> <p><i>Safe Systems Review of Fatal and Serious Injury Crashes in Sydney</i></p>	<p align="center">134 <b>Duc Phan</b> La Trobe University</p> <p><i>Can walking and cycling for train access improve road safety?</i></p>	<p align="center">41 <b>Fritha Argus</b> Main Roads Western Australia</p> <p><i>Automated detection of roadside hazards using Lidar</i></p>	<p align="center">218 <b>Danilo Messias</b> Department of Transport - Victoria</p> <p><i>Developing a marketing strategy to increase Victorians' vehicle safety awareness and influence purchase decisions towards safer vehicles</i></p>	<p align="center">21-25 <b>Tia Gaffney</b> Australian Road Research Board</p> <p><i>Short-term Evaluation of Raised Safety Platforms: A Preliminary Analysis based on Vehicle Speeds</i></p>
12:00-12:15pm	<p align="center">214 <b>Mark King</b> CARRS-Q, QUT</p> <p><i>Injury while drink walking in public places: comparison of patterns associated with vehicle collisions and falls</i></p>	<p align="center">21-30 <b>Masria Mustafa</b> UITM</p> <p><i>Vision Zero for P-Hailing Riders: Understanding Work Demands and Unsafe Work Behaviours</i></p>	<p align="center">111 <b>Amanda Wiltshire</b> Arup Australia</p> <p><i>Complete Streets Victoria: The Cycling Guide</i></p>	<p align="center">110 <b>David Milling</b> ARRB</p> <p><i>Guidelines to provide Roadside Protection for Motorcyclists</i></p>	<p align="center">222 <b>Mahmoud M Masoud</b> CARRS-Q, QUT</p> <p><i>Glare Safety problem in tunnels and underpasses in Australia</i></p>	<p align="center">217 <b>Chris Davis</b> Mildura Rural City Council</p> <p><i>Impact of community reaction on Mildura Council's speed reduction project in residential streets</i></p>
12:15-12:30pm	<p align="center">129 <b>Jacelle Warren</b> Jamieson Trauma Institute, Metro North Health</p> <p><i>The risk and cost of pelvic and lower limb fractures from road transport crashes: Motorcyclists are key</i></p>	<p align="center">175 <b>Raaj Kishore Biswas</b> University of New South Wales</p> <p><i>Definitions and associated factors of headway: a systematic review of passenger vehicle studies</i></p>	<p align="center">234 <b>Phil Gray</b> State Government of Victoria</p> <p><i>Identifying Cycling Stress to Inform Cycling Infrastructure Investment</i></p>	<p align="center">243 <b>Mansour Ranjbar Kahkha</b> World Health Organization</p> <p><i>Demonstrating enhanced Safety Model Corridors in Iran</i></p>	<p align="center">131 <b>Paolo Terranova</b> Virginia Polytechnic Institute and State University</p> <p><i>Motorcycle Active Safety Systems: A cross-national comparison of applicability in the Australian, Italian, and US fleets</i></p>	<p align="center">227 <b>Sovann Kong</b></p> <p><i>Enhancing road safety knowledge and practice around rural school zone in Cambodia</i></p>
12:30-12:40pm	Post session networking	Post session networking	Post session networking	Post session networking	Post session networking	Post session networking
12:40-1:30pm	Lunch, Exhibition, Poster Gallery					

	Concurrent Sessions 6					
Topic	Road design and the built environment	Mobile phones	Impairment – alcohol and drugs	Intersections	Community and Local Government	Symposium 7
1:30-1:45pm	73 <b>Callum Hooper</b> Arup <i>The urban road and street design guide</i>	21 <b>John Willoughby</b> Transport for New South Wales <i>Developing a world-first mobile phone detection camera program in NSW: from no known solution, to operational program in two years</i>	31 <b>Anne Harris</b> Anne Harris Consulting <i>Effectiveness of drink driving countermeasures in Australia: a national policy framework</i>	93 <b>Julianna Bodzan</b> Transport for New South Wales <i>Identifying high-risk intersections by modelling driving behaviour with machine learning methodologies</i>	213 <b>Jay Baththana</b> Abley Limited <i>Using community feedback to complement road safety risk metrics</i>	<p>Creating the business case for a true system for organisations through safety, environment and efficiency</p> <p><b>Jerome Carslake</b> National Road Safety Partnership Program (NRSPP)</p> <p>Lee Sauerwald Uniting Communities</p> <p>Guy Pritchard Sustainability Victoria</p>
1:45-2:00pm	264 <b>Ubaid Quraishi</b> Department of Transport (Victoria) <i>Audio Tactile - Mass Action Development and Delivery</i>	137 <b>Ian Faulks</b> CARRS-Q, QUT <i>Snap-chat – Mobile phone camera enforcement and community attitudes</i>	59 <b>Louise Higgins-Whitton</b> Transport for NSW <i>Development and implementation of New South Wales Drink and Drug Driving Reforms</i>	15 <b>Elizabeth Lee</b> State Government of Victoria <i>Pedestrian occupancy detection (POD) using an optical system at traffic signals</i>	216 <b>Mrinmoy Samadder</b> BRAC University <i>Examining ‘Group Dynamics’: Involving community people towards safer roads</i>	
2:00-2:15pm	14 <b>James Thompson</b> The University of Adelaide Centre for Automotive Safety Research <i>An evaluation of retro-reflective screens to aid conspicuity of trains at passive level crossings at night</i>	96 <b>Lisa Wundersitz</b> The University of Adelaide Centre for Automotive and Safety Research <i>Uncovering driver distraction and inattention in fatal and injury crashes</i>	46 <b>Rhiannon Kelly</b> Transport for NSW <i>Drink driving attitudes and behaviours in NSW</i> 63	235 <b>Sarah Morris</b> Department of Transport <i>Raised Intersections at Traffic Signals in Victoria</i>	44 <b>Kate McDougall</b> Eurobodalla Shire Council <i>Local Government supporting and reinforcing workers returning home safely: case study of John Holland - Batemans Bay Bridge replacement project</i>	
2:15-2:30pm	133 <b>Mel Taylor</b> Macquarie University <i>Floodwater on Roads: Driver behaviour and decision-making</i>	188 <b>Joel Tucker</b> RACQ <i>Set Your Phone Then Leave It Alone – An anti-distraction campaign</i>	<b>Max Cameron</b> Monash University Accident Research Centre (MUARC) <i>Modelling the crash effects of random and targeted roadside drug tests in Victoria, particularly on drug driving involving methylamphetamine</i>	210 <b>Joanne Vanselow</b> Department Of Transport <i>Using LIDAR data for analysing road safety at an intersection – evaluation of the Omni-Aware dataset for road safety research</i>	69 <b>Teresa Williams</b> Road Safety Commission <i>Community Engagement and Attitudes for Road Safety in Western Australia</i>	
2:30-2:45pm	231 <b>Mark Keulen, Henri Sutton and Chantelle Elsley</b> Transport for NSW <i>The Mitchell Highway Safer Asset Cross-Section Pilot Project</i>	88 <b>Will Warner</b> Transport for New South Wales <i>Modelling the Potential Road Trauma Reductions of Mobile Phone Detection Cameras in NSW</i>	122 <b>Matthew Baldock</b> The University of Adelaide Centre for Automotive Safety Research <i>Characteristics of crash-involved drink and drug drivers and motorcyclists</i>	62 <b>Tegan Pearce</b> Department of State Growth <i>Mentoring to increase compliance and road safety</i>	35 <b>John Gaffney / Elizabeth Hovenden</b> State Government of Victoria <i>Towards Linking Climate Phenomena to Road Safety Outcome</i>	
2:45-2:55pm	Post session networking	Post session networking	Post session networking	Post session networking	Post session networking	
2:45:3:15pm	<b>Afternoon Tea, Exhibition, Poster Gallery</b>					
3:15-4:00pm	Chair: <b>Dr Jeff Potter</b> , Principal Policy Advisor, National Transport Commission  <b>Conference wrap up Presentation of conference awards Invitation to ARSC2022</b>					

Extended Abstract Number	Author(s)	Topic	Title	Abstract
3	Clark, T. Gray, S.	Road Environment (ITS - roads) Intelligent Transport Systems in Road Infrastructure	M7 to M2 Pre-congestion speed management	This paper explores the development and implementation of the M7 to M2 Pre-congestion Speed Management trial. This trial was the first of its kind in NSW and will allow motorway operators and road authorities the opportunity to understand the safety and reliability benefits that proactive speed management may bring to Sydney's motorway networks
6	Morgan, R.	Policy Development And Implementation Road Safety Strategy	Paradigm lost – getting beyond the safe system	Every new road safety paradigm is ultimately counter-productive, because it becomes dogma. The <i>Safe System</i> and strategies based on it, like <i>Towards Zero</i> have repeated this truism. Zero is not possible. Pursing it has involved a return to pre-scientific notions of road safety 'solutions' that are ineffective. For example, the 'primacy of speed management' in all Australian road safety strategies has resulted in excessive use of low speed limits – an example of trying to directly modify road user behaviour. The Safe System's core (the body's tolerance to crash forces) is useful, but is only half the story. The other half is the mind's tolerance to complexity and excessive, wrong or misleading information. The author has developed an alternative evidence-based strategic framework. It seeks to avoid dogma. It incorporates the need to understand human behaviour, rather than fight against it. This alternative is the <i>Safety Star System</i> . Details are included.
7	Poynton, J. Burt, D.	Road Safety Audit and Road Safety Review Bicyclists Pedestrians Safer Mobility	A safe access audit tool for active transport	Safe System Solutions Pty Ltd and Victoria Walks worked in partnership to develop a comprehensive auditing and decision support tool on behalf of Banyule City Council. Banyule require the tool to enable them to conduct in-house safe access audits of some of their activity centres in relation to pedestrians, cyclists and mobility scooter users. The tool itself consists of four modules providing 1) criteria checklist, 2) report template for site visits, 3) strategic overview template, 4) a template for recording final decisions.
8	Tan, T. Le, J. Beer, K. Poynton, J. Sherry, D.	Road Furniture (Poles, Signs, Etc) Road Design Motorcyclists Scooters	Audio-tactile Line-marking and perceived motorcycle stability	Audio-Tactile Line-Markings (ATLM) are a road safety feature designed to alert vehicle drivers and avoid lane departures by creating a haptic and audible vibration. There have been concerns by motorcyclists that ATLM could negatively affect the stability of motorcycles. This study qualitatively assesses whether ALTM negatively affect motorcycle stability. Three ATLM configurations were installed and 10 participants were recruited to ride over the ATLM and provide feedback through surveys. The results from the survey analysis indicates that the participants' perception of ATLMs as a potential cause of motorcycle instability had decreased.

<p>14 (also Full Paper)</p>	<p>Thompson, J. Baldock, M. Stokes, C.</p>	<p>Hazard Perception Road Environment Crossings (Pedestrian, School, Rail, Rural/Animal)</p>	<p>An evaluation of retro-reflective screens to aid conspicuity of trains at passive-control level crossings at night</p>	<p>Trains already passing through level crossings in rural areas at night can be difficult for approaching motorists to see. Crashes can occur if the crossing has 'passive' controls (Give way/Stop signs) and motorists fail to stop. Retro-reflective screens on the far side of the crossing to motorists that reflect headlights and produce a 'strobing' effect between carriages could increase train conspicuity. A prototype screen was applied to a crossing in South Australia. Four videos of trains at night from the perspective of an approaching vehicle (conditions: high versus low beam headlights, screen versus no screen) were recorded and used in a reaction time experiment with <math>N=29</math> drivers. With high beams, the screen led to shorter reaction times, which suggests it increased train visibility. With low beams, it led to longer reaction times, which suggests it reduced train visibility or confused drivers. Implications, study limitations and further experimental testing are discussed.</p> <p>(Also see: <a href="https://doi.org/10.33492/JRS-D-21-00007">https://doi.org/10.33492/JRS-D-21-00007</a>)</p>
<p>15</p>	<p>Lee, E. Fitts, A.</p>	<p>Intersections and Roundabouts Crossings (Pedestrian, School, Rail, Rural/Animal) (ITS - roads) Intelligent Transport Systems in Road Infrastructure</p>	<p>Pedestrian occupancy detection (POD) using an optical system at traffic signals</p>	<p>The Department of Transport has approximately 3350 traffic signal intersection in Victoria where around 1500 are Pedestrian Operated Signal (POS) and 325 are Pedestrian User Friendly Intelligent (PUFFIN) crossings using overhead radar detectors to optimise the pedestrian signal settings. The PUFFIN detectors are used to detect all pedestrians crossing the carriageway. The output is used by the traffic signal controller to extend the walk and/or clearance times while a pedestrian is on the crossing. However, there is no information on how many pedestrians and cyclists are waiting to cross. The testing of POD using an Optical system can be used to detect and monitor the volumetric data in the form of pedestrian occupancy ratio in a predetermined area. The main feature is the occupancy mode which allows traffic signal operation to be dynamically adjusted dependent on the volume of people waiting to cross. This is ideal for sites which have varying influx of people using the crossing e.g. school.</p>
<p>16</p>	<p>Bates, L. Seccombe, J.</p>	<p>Young Drivers Novice Driver/Rider Licensing General Enforcement</p>	<p>The effect of parenting styles and differing theoretical frameworks on young drivers self-reported compliance</p>	<p>New drivers are a high risk group for traffic offences. With traditional deterrence appearing to have a more limited impact on young drivers, effective alternatives are needed. The purpose of this study was to identify if parenting style influenced self-reported offending after considering different types of theoretical frameworks. An online vignette study was completed by 1,673 participants who held a provisional (Queensland) or probationary (Victoria) licence. The scenarios were based on deterrence, procedural justice, and third party policing frameworks. In addition to a general decrease in offending, participants that reported having parents that were higher in control indicated that they were less likely to offend when exposed to the third party policing scenario. These results indicate that third party policing has potential to improve compliance rates for young drivers and that it is important to consider parenting style when introducing initiatives designed to increase young driver compliance.</p>

<p>17 (also Full Paper)</p>	<p>Cameron, M. Newstead, S.</p>	<p>Road Safety Strategy Speed Cameras</p>	<p>Increasing the effectiveness of mobile speed cameras on rural roads in Victoria based on crash reductions from operations in Queensland</p>	<p>Mobile speed cameras on Victoria's rural roads are not as effective as they could be due to the site selection criteria, the limited number of sites, and the visibility and predictability of their enforcement operations. Queensland's overt mobile speed cameras achieve substantial crash reductions up to 4 km from rural camera sites due to site selection based only on crash history and randomised scheduling of operations to those sites. New sites in Victoria should be selected as in Queensland and camera visits should be randomly-scheduled. The Victorian Government's announcement to increase mobile speed camera hours by 75% should take the form of at least 75% increase of rural sites. The new sites should be selected on the basis of a serious crash history within 2.5 km. Mobile speed cameras operated at these new rural sites could be expected to save 22.5 fatal crashes and 172 serious injury crashes per year.</p> <p>(Also see: <a href="https://doi.org/10.33492/JRS-D-20-00273">https://doi.org/10.33492/JRS-D-20-00273</a>)</p>
<p>19</p>	<p>Hydon, C. Marko, Z.</p>	<p>Community Programs Road Safety Programs Early Childhood Road Safety Education – general and other</p>	<p>Active and safe: young children as engaged road users in their communities</p>	<p>Starting Out Safely is an early childhood road safety education (RSE) program focused on children, parents, and educators working together to guide children's learning and becoming safe and independent road users. Funded by the Victorian Government, the program has been developed in collaboration with leading experts through evidence-based research and best-practice principles. A 2019 Inquiry Project was undertaken to challenge educators to abandon views of RSE as one-off curriculum episodes and work locally with children to understand road safety issues and make positive change. Participants were encouraged to use RSE as a community engagement mechanism to enable children to realise their full potential as citizens. The project findings will be shared with a view to motivate early childhood services to contribute to the Towards Zero initiatives. Examples showcase how RSE can be embedded into curriculum to create safer communities for everyone.</p>
<p>20</p>	<p>Hardiman, J. Hardiman, M. Hay, R. MacFarlane, M. Redwood, P. Sycz, D. Walker, L.</p>	<p>Crash Investigation – including investigation methods &amp; technology Crash Reconstruction – including computer simulation Statistical, Epidemiology and Other Road Safety Research Methods</p>	<p>Comparison of skidding vehicle drag factors on various surfaces</p>	<p>In 2018, there were 1,146 deaths on Australian roads with vehicle speed estimated to be a direct factor in 30% of all road accidents. (Bitre, 2019) Collisions are analysed to determine causation including driver behavior, speed, vehicle safety and road design. Vehicle speed analysis relies heavily on the determination of the drag factor at any collision scene. Test skids at the collision site are regarded as the most reliable method to determine drag factor. The use of published drag factor tables has been criticised as the results are not case specific. Since 2002, Victoria Police (VP) have performed over 1275 test skids on Victorian Roads. Tests have been performed on various surfaces with and without anti-lock braking (ABS) producing results consistent with published worldwide data sets. Results support the use of published data sets for speed determination when test skids cannot reasonably be conducted at the collision site.</p>

21	Willoughby, J. Carlton, B. Cavallo, A. Hayes, P. Gavin, A. Higgins-Whitton, L. Jansen, A. Legg, S. Lewandowski, V. McCaffery, T. Murdoch, C. Newstead, S. Sakar, S. Stephan, K. Stephens, A. Thompson, J. Wall, J.P. Warner, W.	Speed Cameras Enforcement Programs Enforcement Technologies Penalty Systems	Developing a world-first mobile phone detection camera program in NSW: from no known solution, to operational program in two years	In NSW since 2012, there have been over 182 casualty crashes involving a driver using a hand held mobile phone – resulting in at least 13 deaths and 243 injuries. The true number is likely much higher due to under reporting. In less than two years Transport for New South Wales (TfNSW) turned an idea for tackling illegal hand held phone use while driving into a world-first road safety initiative. Seeking a fresh approach, the NSW Government stimulated the market to develop a solution by creating the legal framework for camera detected offences using established principles from speed enforcement. A pilot proved that the camera system could reliably detect illegal mobile phone use and informed the design of an end-to-end operating model. The NSW Mobile Phone Detection Camera program became operational in December 2019 and is expected to save around 100 fatal and serious injury crashes over five years.
23 (Poster)	Felsch, J.A. Sutton, P. Attard, A. Ditton, A. McMenamin, P.	Driver Risk Older Drivers & Road Users Hazard Perception Education – general and other	Caravan Safety Awareness Project in northern NSW	Caravanning is more popular than ever in Australia. There are now nearly 154,400 caravans registered in NSW with caravan registrations rising 53% in the 7 years to 2019. In NSW, over the same period, there were a total of 2,318 crashes involving caravans/ trailers, of which 19.1% were serious injury or fatal crashes. To engage caravanners, industry associations, caravan clubs, caravan safety educators and improve caravan safety awareness in Northern Region, Transport for NSW (TfNSW) has collaborated with NSW Police Highway Patrol. TfNSW has delivered engagement activities in northern region and the Centre for Road Safety has developed a caravan safety webpage and collateral for statewide use. Other regions in NSW, also noticing caravan safety concerns, are keen to learn from our findings and implement our initiatives
24	Soole, D. Anderson, W. Smith, T.	Driver Risk Enforcement Technologies Speed Cameras Speed, Speeding & Travel Speeds	The attribution of casualty crashes to low-level speeding in Queensland	The positive relationship between vehicle speeds and crash risk and severity are well understood. This paper sought to utilise speed probe data and existing crash risk estimates to determine the proportion of crashes attributable to various speeds above the posted limit on Queensland roads, with a particular focus on low-level speeding (1-10 km/h above the limit). The findings demonstrated that the majority of speeding motorists were engaged in low-level speeding. Analyses indicated that between 5.9% and 19.2% of all casualty crashes were estimated to be attributable to low-level speeding, with proportions typically higher in lower speed limit zones. Conversely, it was estimated that between 19.9% and 67.0% of speed-related crashes were attributable to low-level speeding, with proportions typically greater in higher speed limit zones. Further data analyses stratified a range of spatial and temporal variables. Policy implications of the findings are discussed.

25	Symmons, G. Simpson, P.	Community Programs Driver Psychology Road User Training – General (Bicyclists, Workplace, OHS, Etc.) Young Drivers	LET'S #GOSAFELY - A community-based multi stakeholder approach to road safety education for young adult road users	Since 2014, the Fit to Drive Foundation's F2D Year 11 (F2D) Workshop, a community-based road safety intervention, has reached more than 120,000 students throughout Victoria. The F2D Program is delivered by trained youth as facilitators and ambassadors to empower young people to talk about making good decisions on the road and be safer road users. The F2D Program integrates research, program logic development and delivery and evaluation in a multi stakeholder approach to road safety education for young adult road users that is local, community-based and long term. The paper will explore the effectiveness of the F2D Program in reducing road trauma in the community. Participant feedback from students and teachers is continuously measured and insights gained evolve the program, resulting in a contemporary and positive approach to community-based road safety education for all stakeholders. This paper will share these learnings.
28	Hassan, A. Reardon, N. Mungkung, M.	Crash Data Analysis Pedestrians	A structural equation model for pedestrian crashes in sydney	Over the five year period between 1 January 2014 and 31 December 2018, pedestrians were killed more than any other road user in Sydney, making up around 40% of the road fatalities in Sydney, New South Wales (NSW) and the trend is consistent in every year over the five year period. In this paper a structural equation model is proposed to identify factors impacting pedestrian crash severity in Sydney. Impact of road characteristics, environmental factors, driver characteristics, and pedestrian characteristics were analysed to identify their impact on crash severity. Numerous iterations were conducted to achieve statistically significant and a good-fit model. Using this, countermeasures were proposed to address these crashes, particularly fatal and serious injury crashes, across the Safe System pillars.
31	Banyer, G. Howard, E. Harris, A. Murdoch, C. Graham, R. Higgins-Whitton, L.	Drink Driving Driver Risk General Enforcement Policy Development And Implementation	Effectiveness of drink driving countermeasures in Australia: a national policy framework	Drink driving is a persistent problem and remains one of the leading causes of death and trauma on Australian roads. This project collates statistics of alcohol-related trauma over a three year period (2015-2017) across Australian jurisdictions, and reports the differing legislation, penalty and enforcement practices across Australia. By building a picture of the trauma and understanding the different starting points of each jurisdiction, this Austroads project delivers a national policy framework that brings together current and potential countermeasures to reduce this trauma and work towards eliminating drink driving deaths and serious injuries. A staged approach to the implementation of evidence-based solutions is offered for use by different jurisdictions as appropriate. Strong empirical evidence is provided for countermeasures including for lowering the legal BAC limit for all drivers, improved deterrence through highly visible and randomised enforcement and working more closely with alcohol and other drug sectors to manage alcohol dependent drivers.

32	Aisenberg, A.	Advocacy Bicyclists Communication and Media Statistical, Epidemiology and Other Road Safety Research Methods	BikeSpot 2020 – Crowd mapping cycling stress across Victoria	Concerns about safety and crash risk, both real and perceived, are the most important determinants of whether people cycle. Cycling stress (particularly in traffic) is instrumental in influencing the choice to ride. If a single section of a route is perceived to be highly stressful, many people, particularly new riders, will likely decide not to ride. BikeSpot 2020, a collaboration between CrowdSpot and the Amy Gillet Foundation, is a project that maps the safety concerns and level of cycling stress experienced by cyclists across Victoria. Outcomes from this project will help inform partnering local and state government agencies on specific locations that have relatively high level of traffic stress and how to maximise the return on the investment into infrastructure for safe cycling.
34 (Poster)	Ibrahim, M. Logan, D. Koppel, S. Fildes, B.	Driver Risk Safer Mobility Safer Transport & Mobility	Using relative risk of different travel options as part of journey planning attributes – case study from Victoria-Australia	Demand for journey planning systems that generate different options is increasing to help people get to places more efficiently by providing information on time, cost and emissions that aim to ease congestion and encourage more sustainable travel. The aim of this study was to add travel risk as an element into encouraging safer travel behaviour in addition to the other attributes. By using injury and travel data in the Australian state of Victoria between 2012 and 2016, this study estimated the fatal and serious injury (FSI) rates per travel distance across nine travel modes. These rates were then applied to a real-world case to illustrate how safety can also be calculated in the form of relative risk between different available options as part of the modal choice process.
35	Gaffney, J. Hovenden, E.	Road Environment Safer Transport & Mobility Education – general and other Crash Data Analysis	Towards linking climate phenomena to road safety outcome	Climate and its many weather manifestations can explain the significant variations in Victoria's annual road fatalities. This paper illustrates how climate phenomena and weather metrics can increase crash risk, identifies the need for intervention during certain weather events and provides pathways for further research. There is a linkage between fatalities and key meteorological climate drivers (macro-metrics) and their daily weather manifestations (micro-metrics). The key climate drivers for Victoria and south eastern Australia produce complex interactions forming long-term weather patterns influencing the occurrence of fatal crashes. Analysis of Victorian crash records has found that weather is a significant factor involved at least 10% of fatalities. Understanding how climate influences crash occurrence can provide an understanding of the variations seen in fatalities over the past 30 years. Research in this area can be used to develop appropriate strategies to improve road safety and help reach the target of zero deaths.

36	Cosimo Lucci, MSc Savino, G. Baldanzini, N. Pierini, M.	Autonomous Vehicles Crash Avoidance and Crash Severity Reduction Motorcyclists Scooters	The acceptance of Autonomous emergency braking system for motorcycles: results before and after testing	Autonomous Emergency Braking (AEB) is a promising technology in the future of motorcycle safety, since it could be effective in reducing the consequences of crashes. To evaluate whether a personal experience of the intervention may influence the acceptance of such a system, an analysis of the results of a field study conducted in realistic pre-crash manoeuvres and involving 31 participants was carried out. Among users who applied for volunteering in field tests with motorcycle safety systems, the pre-test acceptability of AEB was generally lower compared to that of safety system already installed on standard vehicles. After field-testing automatic braking interventions, the participants' opinion about the potential effectiveness and reliability of the system was more positive; none of the participants considered the system damaging anymore. Field testing motorcycle autonomous emergency braking in realistic pre-crash manoeuvres turned out to have a positive influence on the acceptability of the system among our participants.
37	Roberts, P. Meuleners, L.B. Fraser, M.L.	(ITS - roads) Intelligent Transport Systems in Road Infrastructure Driver Risk Hazard Perception Speed, Speeding & Travel Speeds	Impact of a rural intersection active warning system (RIAWS) on driver speed: a driving simulator study	Rural Intersection Active Warning Systems (RIAWS) are an innovative road safety treatment designed to slow traffic on major approaches to a high-risk rural intersection when vehicles are turning or crossing into or out of the side roads, thus reducing fatal and serious casualties. A 2x2 experimental driving simulation study was undertaken which aimed to determine the impact of signage (RIAWS versus traditional painted) and sign content (80km/h versus slow down) on drivers' instantaneous speed at rural intersections. The RIAWS "80km/h" sign resulted in significantly lower instantaneous speeds than all other types of signs including RIAWS "slow down" signs ( $p < 0.001$ ), traditional painted "80km/h" signs ( $p < .05$ ) and traditional painted "slow down" signs ( $p < .01$ ). Overall, the study found that RIAWS "80km/h" sign and not the RIAWS "slow down" sign provided the most effective option for reducing driver speeds on approach to rural intersections.
39	Larue, G.S. Watling, C.N. Black, A.A. Wood, J.M.	Crossings (Pedestrian, School, Rail, Rural/Animal) Distraction & Inattention Pedestrians Signage & Signalisation	Increasing awareness of distracted pedestrians at railway level crossings with illuminated in-ground lights	Pedestrian distraction is a growing problem. Current signage at railway level crossings may not be effective for pedestrians distracted by mobile devices, as it is designed for users looking ahead when walking rather than looking downwards as when using a mobile. Illuminated in-ground lights are an innovative solution to address this issue but have not been evaluated for use with distracted pedestrians. We conducted a 2 (in-ground lights yes/no) x 3 (distraction task none/auditory/visual) repeated measures field study (N=34) at a railway level crossing to assess whether distracted pedestrians could detect illuminated in-ground lights and how this impacted on visual scanning behaviour. Pedestrians detected the lights as accurately when distracted (visually or auditorily) compared to when not distracted, and eye scanning behaviour of the rail tracks with the in-ground lights was the same as for non-distracted levels. This is the first study to suggest that illuminated in-ground lights could be effective in attracting the attention of distracted pedestrians at railway level crossings.

40	Kariyawasam, C.	Road Safety Strategy	Road safety gains from small speed reduction wheatbelt road in rural WA	Safe roads and roadsides, safe Speeds, safe vehicles and safe people are cornerstones of the road safety system (Cairney, Imberger, Turner, 2013). When providing safe roads and roadsides, road geometry is a vital factor, in assessing the suitable speeds that most vehicles operate on the road (Semeida, 2013). For low volume, rural roads with substantial substandard geometry compared to the posted speed, geometric improvements are not justified due to the high cost. A better approach would be speed management. This case study focuses on the Chidlow York Road, a 44km long regional, freight, tourist and inter-town route in the Main Roads Wheatbelt Region of Western Australia. This road is known for its poor geometry; 110km/h posted speed and carries around 2000 vehicles daily. Reducing the speed limit by 10km/h to 100km/hr along with minor improvements, a crash reduction of 34% was observed (IRIS database, 2019).
41	Argus, F.	IRAP, AusRAP, etc.	Automated detection of roadside hazards using Lidar	Main Roads Western Australia undertook development of AusRAP star rating using existing corporate inventory data to meet reporting commitments to the National Road Safety Strategy. Throughout this work, both the advantages and limitations for using inventory data were highlighted. One such issue is with detection and identification of roadside hazards (e.g. trees, power poles, buildings). Therefore, Main Roads has partnered with Anditi to test the potential for automating the detection of road and roadside features using mobile Lidar and 360° imagery data. Two thousand kilometers of state road network have been selected, broken into five categories with differing roadside archetypes. Analysis conducted can detect and identify various roadside hazards, and even differentiate between tree trunks and power poles. This fresh innovative approach to data sourcing for safety risk assessment has real potential and may ultimately help towards the development of up-and-coming tools such as ai-RAP.
42 (Poster)	Argus, F.	IRAP, AusRAP, etc.	Using road inventory data to produce AusRAP star ratings	Actions 2 and 3 of the National Road Safety Action Plan 2018-2020[1] collectively aim to reduce risk associated with infrastructure by setting targets for the proportion of travel on state and national routes with 3-star (or better) AusRAP star ratings. In order for Main Roads Western Australia to determine how the state is progressing towards these targets, it first needed to rate the network using AusRAP. As funding for video coding was unavailable, an AusRAP upload file was developed using existing corporate inventory data. This project established business and coding rules to convert inventory data into AusRAP fields. This has enabled the entire state road network to be AusRAP star rated at a fraction of the cost of video coding.

43	Assi, G.S.	Driver Psychology Young Drivers	Self perception, driving patterns and gender differences on psychological measures of young Indian drivers	A study of 395 young Indian drivers (199 males and 196 females) exploring their socio-demographic profile along with gender differences was conducted. Differences among male and female drivers on several parameters were sought. This study provides an insight into what sets male and female drivers apart on their driving license patterns, perceptions of their own self on being aggressive, risk-taking or an unsafe driver. The socio-demographic profile looked into their driving license and driving test parameters. Psychological constructs of driving anger and dangerous driving were administered to the participants. The findings reveal that there were significant gender differences on sub-scales of driving anger, where females were found to experience anger on the hostile gestures of other drivers on roads. Significant gender differences on the sub-scales of dangerous driving was also found where males were found to score higher on dimensions of aggressive and risky driving than their female counterparts.
44	McDougall, K. Pritchard, J.	Fatigue Workplace and Work Related Road Safety Road Safety Programs Education – general and other	Local government supporting and reinforcing workers returning home safely: case study of John Holland–Batemans Bay bridge replacement project	Eurobodalla Shire Council (ESC) collaborated with construction company John Holland’s Batemans Bay Bridge replacement project team, implementing Towards Zero “Road Safety and Your Work; a Guide for Employers”(1) (TZRSAYW). After assessing road safety risks within the John Holland workforce, driver fatigue was targeted as 55% of project workers live outside the Eurobodalla and travel home regularly. Driver fatigue in Eurobodalla accounts for 23% fatal and 11% casualty crashes 2014 to 2018. Due to unprecedented bush fires in 2019-2020 in Eurobodalla, additional Towards Zero messages were delivered to ensure the safety of workers travelling home from the workplace, particularly on weekends and peak holiday times.
45	Hardiman, M.	Speed, Speeding & Travel Speeds Autonomous Vehicles Legislation and Law Crash Investigation – including investigation methods & technology	Real world application of crash data from vehicle event data recorders - a case study	The use of crash data obtained from Event Data Recorders (EDRs) has grown significantly since their introduction in 1997 and is now considered an integral element of collision reconstruction. EDR data has been accepted in criminal cases in the USA, England and Australia (Technavio, 2017), with Victoria Police (VP) presenting crash data in criminal matters since 2010. The use of this data has provided corroboration of existing reconstruction methods and previously unknown information where there is no physical scene evidence. In this case, two vehicles, both equipped with EDRs were involved in a collision at a signalized intersection, resulting in the death of two occupants in one vehicle. The data obtained from the EDR was shown to be highly accurate and robust, leading to a successful prosecution. The devastating loss of life in the high-speed collision detailed in the case study highlights the true value of the information obtained from EDRs.

46	Kelly, R. Rath, N. Guyader, F. Elliot, D. Filardo, L. Fernandes, R. Higgins-Whitton, L.	Drink Driving	Drink driving attitudes and behaviours in NSW	Drink driving remains problematic in NSW, contributing to 17% of road fatalities in 2019. A sample of 2,133 NSW drivers was surveyed regarding their attitudes and behaviours towards drink driving. Twenty-five per cent had driven over the legal blood alcohol concentration (BAC) limit in the last six months, up from 18% in 2014. Prevalence of drink driving was higher for those aged 16-25, especially for regional-based females (50%). Drink drivers were more likely to endorse driving over the legal BAC limit in certain situations such as driving on quiet roads or short distances and were less likely to think they would get caught. However they were more likely to be aware of new drink driving penalties introduced in 2018-19, and to say these would deter them from drink driving. NSW drink driving campaigns are currently being reviewed with the aim of incorporating these findings into future education and awareness campaigns.
48	Ahmad, I.F. Fildes, B. Logan, D.B. Koppel, S.	Restraints Child Restraints Legislation and Law Road Safety Programs	Findings on child restraint system (CRS) use in Dubai, United Arab Emirates	This study aimed to investigate parents' attitudes, knowledge and behaviours relating to safe child occupant travel in the Emirate of Dubai in the United Arab Emirates (UAE). A survey was conducted with 815 parents/carers who were responsible for 1,694 children (aged between birth and 10 years) to investigate their use of child restraint systems (CRS) and booster seats for their children, their self-reported use of appropriate restraints for their child's age-group, issues regarding restraint selection and installation, and knowledge regarding the restraint legislation. Overall, 20.6 percent of participants reported that they 'never' used a CRS and booster seat for their eldest child who was aged 10 years or younger while travelling in a motor vehicle. In addition, the proportion of eldest children who were 'never' restrained increased with their age. Future research will validate this self-reported child restraint use data with objective data from observations of real-world child restraint use behaviour in UAE.
49	Doukouris, K. Beer, K.	Education – general and other	Road safety capability requirements for road authorities	The Safe System road safety philosophy requires roads to be designed and managed so that death and serious injury are avoidable. The basic principles are: a. Humans are fallible and will inevitably make mistakes. b. Despite this, road trauma is not inevitable. c. To prevent trauma, the road system must be forgiving. Successful road safety requires staff with the appropriate skills in the Safe System (capability), and sufficient numbers of staff to effect noticeable changes (capacity). Capability development training for lead road safety authorities in Australia, New Zealand and South-East Asia, enabled us to identify those capability areas that need to be strengthened or are particularly effective. This depends on the career phase of the practitioner as well as the particular concerns of their jurisdiction. For example, motorcycle safety is particularly problematic, especially in the Asian region where motorcycles are the predominant mechanised transport mode.

51	Molloy, O. Molesworth, B. Williamson, A.	Speed, Speeding & Travel Speeds Young Drivers Driver/Rider Training Road User Training – General (Bicyclists, Workplace, OHS, Etc.)	The impact of the medium in which feedback is presented on young drivers' speed management behaviour	The aim of the present research is to examine the effect of the medium in which feedback is delivered (verbal, written, graphical) on young drivers' speed management behaviour in a 60km/h speed zone, immediately post-training and one week post-training. Sixty young drivers, randomly allocated to one of four feedback groups (i.e., Control, Verbal feedback, Written feedback, and Graphical feedback) completed one training and two test drives using an instrumented vehicle. The results showed that feedback presented graphically was most effective in reducing the mean speed travelled in the 60km/h speed zone. These effects were present immediately following training as well as one week later. These findings have important implications for the development of a new approach to improve young drivers' speed management behaviour.
52	McDougall, K. Dunn, A.	Road Safety Audit and Road Safety Review Road Safety Strategy	Driving safer rural roads – a systematic safe system review of a local government rural road network	Eurobodalla Shire Council (ESC) is working towards achieving zero deaths on their local road network through commitment of safe system approaches including building network capacity and implementing safety improvements. In 2019, ESC select road management staff inspected all 280km of rural and regional sealed roads, systematically documenting 911 identified road safety issues. The resultant Road Safety Review integrated into the Eurobodalla Road Safety Plan 2019-2021 (RSP) ensures ESC's whole of network and route approach targets high priority actions addressing funding of hazard elimination, prioritizing road maintenance, while promoting ESC staff to train others in identifying and reporting hazards.
53	Hassan, A. Reardon, N. Nguyen, T. Mungkung, M.	Road Environment Crash Data Analysis	Safe systems review of fatal and serious injury crashes in sydney	The Safe System approach involves different elements of the system working together to help eliminate fatality and serious injury. This study reviewed 14,064 fatal and serious injury (FSI) crashes that occurred in Sydney during the five year period from 1 January 2014 to 31 December 2018. The analysis was conducted using descriptive analysis and the chi-square test. The review identified common FSI crash factors across Safe System pillars (roads, speed, vehicles, people) based on crash data. Results showed that road surface condition, type of location, speeding, age of pedestrian, and license status were the common factors that affected the FSI outcomes.

55	Smith, C. Wold, C.	Driver Psychology Education – general and other Post Crash Rehabilitation	Road trauma support WA: using a public health approach to reduce the long term effects of road trauma	Injury Matters provides Road Trauma Support WA (RTS WA), a state-wide service assisting anyone affected by road trauma, regardless of when the incident occurred, or the person's level of involvement. The purpose of this project is to share evaluation findings of applying a public health approach to RTS WA and to inform the service to meet the need of people impacted by road trauma. In 2018, a comprehensive evaluation framework was developed and implemented to show the impact of the service. The annual survey findings indicated 78.73% (n=37) of counselling clients incorporated topics that were discussed into their everyday life. Whilst service users have engaged with RTS WA for a specified road incident, the service often identifies complexities and underlying mental health concerns. This is addressed through a public health approach to support prevention strategies, as well as intervention strategies for those impacted by road trauma.
56	Chevalier, A. Ledger, S.A. Shaz, K Wright, C. Wall, J. McCaffery, T.	Driver Psychology (ITS - vehicles) Intelligent Transport Systems in Vehicles Statistical, Epidemiology and Other Road Safety Research Methods	The CITI connected light vehicle study: lessons learnt	The Cooperative Intelligent Transport Initiative (CITI) aims to investigate the safety benefits, acceptance, and issues surrounding deployment of cooperative intelligent transport systems (C-ITS). As part of CITI, members of the public consented to participating in a field operational test (FOT) which involved fitting C-ITS technology to their light vehicle for approximately 10 months. Members of the research team provided input on lessons learnt from the FOT which were summarised into issues, future actions, and what was done well. Strengths of the FOT related to achieving the aim to capture findings to inform considerations about wider roll out of C-ITS. Other strengths related to the training and equipment installation and maintenance processes. Known limitations of the FOT included the sample size being insufficient to investigate the safety benefits of C-ITS. Suggestions to address this included a trial with a larger participant sample size, and increasing the amount and types of equipped infrastructure and alerts. Key lessons learnt relate to improvements to the human-machine interface, technology configuration, and data capture. It is envisaged these lessons will assist developers and researchers undertaking trials of similar technologies.
57 (Poster)	Cohen, R.A. Rowe, D. Everingham, S. Graham, R. Parnell, H.	Workplace and Work Related Road Safety Fleet Safety Community Programs Road Safety Programs	The next frontier: Road safety in the workplace	In NSW, around one in three workplace fatalities occur while driving or riding for work. It is the number one cause of death in the workplace and for many employers it is their greatest workplace risk. Under the <i>Work Health and Safety Act (2011)</i> , all employers in NSW have an obligation to ensure their workers have a safe place to work. Transport for NSW has developed a suite of resources to help employers embed a positive road safety culture in their workplace, with the aim of highlighting the significance of the risk while creating an ethos of shared responsibility.

58	Wood, J. Brough, D. King, M. King, N. Bentley, L.A. Fylan, F. Black, A.A.	Pedestrians Personal Protection – Helmets, Clothing, etc.	Making nighttime pedestrians safer using innovative clothing designs	Nighttime pedestrians are at significant risk of being killed or seriously injured, because drivers often fail to see them in time to avoid a collision. Clothing incorporating retroreflective markers on the moveable joints creates a visual perception of 'biomotion' and improves nighttime pedestrian conspicuity. This study investigated whether biomotion-enhanced clothing retains its conspicuity if adapted to make it more acceptable to wear. In a nighttime closed road study, we compared the relative conspicuity of pedestrians to young drivers with normal vision when pedestrians wore biomotion strips of different thicknesses and patterns. versus other typical clothing worn by nighttime pedestrians. Results showed that all the biomotion clothing resulted in significantly longer conspicuity distances than sports, fluorescent yellow or black clothing (4x longer distances than black clothing). These effects were evident regardless of pedestrian orientation and have implications for the design of clothing for walkers and runners to enhance their nighttime safety.
59	Higgins-Whitton, L. Sterling, K. Murdoch, C.	Drink Driving Drug Driving Enforcement Programs Penalty Systems	Development and implementation of New South Wales drink and drug driving reforms	In 2018/2019, NSW introduced enhanced penalties for drink and drug-driving offenders. The reforms expanded alcohol interlock requirements to middle range offenders, vehicle sanctions to certain repeat drink drivers, and introduced penalty notices coupled with automatic licence suspension for lower range offences. Key implementation challenges included responding to mixed stakeholder views, managing change across agencies, and providing effective communications. Complementing the reforms, offender rehabilitation courses in NSW are being reviewed to expand reach to more offenders. The number of roadside alcohol and drug tests is also increasing. A multi-stage evaluation is planned, with an operational review due late 2020.
60	Richards, M. Mudford, J.	Driver Risk Young Drivers Community Programs Education – general and other	TAC L2P Program Expansion and Improvements	The TAC L2P Program is a funded initiative by the Transport Accident Commission (TAC) and coordinated by the Department of Transport (formerly VicRoads) to provide supervised driving experience to young learner drivers between the age of 16-21 years. In 2018, the former VicRoads commissioned an evaluation and business case to analyse the program's performance and contribution to young driver safety in Victoria. The evaluation provided insights into the economic and social benefits generated by the program in Victoria. In addition to making a significant contribution to road safety, L2P was found to generate significant social and economic value by increasing economic participation and reducing social isolation. A number of improvements to the program were recommended and have now been actualised and successfully rolled out over 19/20.

61	Zurlinden, H. Hovenden, E. Gaffney, J.	Road Safety Strategy	Can I stop? Considering any opportunity to influence the multidisciplinary factors that result in a crash.	While over recent decades significant gains have been made in reducing the number of road traffic related fatalities in Victoria and Australia, in absolute terms this has started plateauing some years ago. This contrasts with the ambitious goal to achieve (close to) zero fatalities. The need for a significant change in road safety management has been identified (Wooley & Crozier, 2018). Based on insights gained during practical road traffic management, a study tour of nine countries (Gaffney, 2016), and a very comprehensive literature analysis, many opportunities to strengthen the current road safety work were identified. This includes an increased, vehicle-centred focus on crash avoidance, the reduction of traffic complexity and mental workload, the provision of targeted dynamic information of inclement weather and traffic conditions, and an integrated emergency response. This article aims at stimulating broad discussions among road safety experts for the development of next-generation road safety strategies.
62	Pearce, T.	Young Drivers Community Programs Road Safety Programs Novice Driver/Rider Licensing	Mentoring to increase compliance and road safety	Previous studies have indicated that unlicensed drivers are more likely than licensed drivers to be at fault and more seriously injured when involved in a crash. Having never possessed a driver licence is more prevalent among people with socio-economic disadvantage, low levels of literacy, difficulty understanding English language, difficulty establishing identity, socio-economic disadvantage or living in remote communities. The Tasmanian Learner Driver Mentor Program (LDMP) was established to simultaneously address the barriers to entering Tasmania's Graduated Licensing System (GLS) and to increase safe driving practices through compliance with GLS requirements. Programs are delivered by community-based organisations and give disadvantaged learners access to a vehicle and volunteer mentor supervisor drivers (mentors) who receive specific training relating to social issues that can contribute to unlicensed driving and unsafe driving behaviours.
63	Cameron, M. Newstead, S. Clark, B. Thompson, L.	Road Safety Strategy Drug Testing	Modelling the crash effects of random and targeted roadside drug tests in Victoria, particularly on drug driving involving methylamphetamine	The prevalence of Methylamphetamine (MA) in drivers on the road and the seriously injured has trended up steeply in Victoria during the last decade. Drug-driving with MA can be deterred by increasing the positive detection rate from roadside drug testing, particularly by targeted testing. Recent research has modelled the relationships between prevalence of THC and MA in seriously injured drivers and (a) random and targeted drug tests during 2006-2016 and (b) the positive detection rates from these tests. The 50% increase in roadside drug tests in Victoria during 2019, particularly targeted tests, is estimated to have saved 3 fatal crashes and 55 serious injury crashes. Further increases in targeted and random roadside drug tests are warranted, up to at least 426,500 total tests per year, and saving 24.5 fatal crashes and 140.5 serious injury crashes per year.

64	Smith, C. Sweeney, R.	Distraction & Inattention Driver Psychology Heavy Vehicles - Trucks, Buses, Hazardous Materials Road Safety Programs	Development of a truck driver public health project: mental and physical safety (MaPS) on our roads.	Individual, environmental and organisational factors can contribute to poor physical and mental health outcomes among truck drivers. The Injury Matters project, Mental and Physical Safety (MaPS) on our Roads, targets health issues facing Western Australian (WA) truck drivers and keeping them safe on our roads. A co-design approach has been applied to inform the MaPS on our Roads strategies. During the consultation phase, surveys, in-depth interviews and focus groups were conducted with WA's heavy vehicle industry. Overall results indicate that WA truck drivers frequently witness road traffic incidents while at work and are aware further actions are needed to improve their health status. However they experience a number of barriers to engaging in existing health and wellbeing initiatives. Consultation results have been used to inform the MaPS project focus areas, engagement strategies and future work that aims to improve the mental and physical safety of WA's heavy vehicle operators.
65	Beer, K. McCardel, M.	Road Environment Autonomous Vehicles Safer Transport & Mobility	Roads that cars can read assessment: practical applications in nsw	A 100 point 'Roads That Cars Can Read' checklist suited to Australian conditions was developed by Safe System Solutions Pty Ltd for Transport for NSW. This checklist was used to undertake Route Risk Assessments for three regions: the planned Smart Shuttle Autonomous Vehicle (AV) route in Olympic Park, Sydney and two planned regional automated vehicle trials; one in Armidale and one in Newcastle. The Roads That Cars Can Read Route Risk Assessments revealed numerous risks that may affect performance of autonomous vehicles. This paper details the key elements of a 'Roads That Cars Can Read' assessment and identifies issues for road designers and road operators when managing a road for autonomous vehicles.
68	McGrane, D. Terrell, M. Hurnall, J.	Speed, Speeding & Travel Speeds Signage & Signalisation NCAP And Consumer Test Ratings	ANCAP speed limit information function assessment	ANCAP have conducted testing and assessment of Safety Assist functions of vehicles since 2018. This includes performance assessment of a Speed Limit Information Function (SLIF) through on-road testing. A range of current model vehicles are fitted with a SLIF that can successfully detect and present applicable speed limits to the driver. In 2018 to 2021 ANCAP assessed 81 vehicles fitted with SLIF with the majority of the tests conducted in Sydney and Melbourne. This paper will outline how ANCAP undertakes the assessments, discuss the findings of these assessments and the issues discovered with the signs, locations and maps. ANCAP found there is inconsistency in signage around Australia making recognition by the vehicle difficult and inconsistent. The placement of road signs and street trees also must be considered in the location of a speed limit sign or a conditional speed limit sign.

69	Williams, T.	Drink Driving Distraction & Inattention Speed, Speeding & Travel Speeds Driver Risk	Community engagement and attitudes for road safety in Western Australia	As a result of a review of the Western Australian Road Safety Commission's (Commission) public participation and engagement activities carried out during 2019, broad interest in the Commission's community attitude and behaviour research was generated. The scope of this paper is the reporting and discussion of the Commission's: <input type="checkbox"/> community attitude and self-reported behaviours relating to drink driving, seatbelts, mobile phone use and speeding; and; <input type="checkbox"/> community perceptions and beliefs regarding road safety in Western Australia (WA) using the Kantar Public 10C Citizen Engagement Framework. Several years of survey results are provided and associated results from WA's driver segmentation research and road safety strategy development are discussed. Additionally, how the 10C framework results are likely to influence the development of WA's road safety strategy 2020 – 2030 outlined in conjunction with results from the community consultation process conducted for the development of the strategy.
70	O'Donovan, S. van den Heuvel, C. Baldock, M. Byard, R.W.	Driver Risk Older Drivers & Road Users Crash Data Collection Data Linkage	Cardiac disease and driver fatality	A retrospective review of autopsy files at Forensic Science South Australia (FSSA) in Adelaide, Australia was undertaken over a 13 year period between January 2005 and December 2017 for motor vehicle drivers aged $\geq 40$ years who died while driving a vehicle. Autopsy examinations were performed on 303 drivers and 72 passengers. Of those traumatic fatalities, 48 (15.8%) of drivers had severe stenosis compared to 15 passengers (20.8%) and was not statistically significant. Although a concern was that drivers with significant cardiac disease may have increased rates of death in crashes with the causative role of the underlying cardiac disease obscured by trauma, this does not appear to be the case. Instead there is a distinct subgroup of drivers who die from cardiac events, and not trauma, while driving who may be increasing in number given the aging population.
72	Whyte, T. Kent, N. Bilston, L. Brown, J.	Child Restraints Crash Testing Biomechanics Crash Data Analysis	Side impact intrusion in child passenger deaths and the performance of child restraint systems	Side impact crashes are more likely to cause intrusion into the occupant space than other crash types which is a significant risk factor for serious injuries to child passengers. All child deaths in NSW from 2007 to 2016 were reviewed in this study, finding that intrusion into the occupant space appears to be the most significant factor related to child passenger deaths when children are appropriately and correctly restrained. Laboratory tests were devised and performed to examine the influence of intrusion and door topology on the injury risk of restrained child passengers. Armrest size and shape was found to affect head injury risk, with a flat door providing the lowest risk. This work demonstrates that optimising compatibility between vehicles and child restraints may be a way to minimise child injury risk in side impacts when children correctly use appropriate restraints.

73	Przibella, S. Ashton, R. Hooper, C. Rowland, M. Hall, P. Røhl, A. Kvist, S. Dockstader, C.	Road Environment Road Design Land Use & Urban Planning	The urban road and street design guide	What do safe urban streets look and feel like? The Victorian Department of Transport (DoT) is developing the <i>Urban Road and Street Design Guide</i> , a design guide for urban roads and streets to help answer this question. The project is a powerful opportunity to align the Department's Movement and Place Framework with safe systems thinking. Lead consultants Arup alongside Gehl have prepared planning and design advice to help practitioners achieve a vision for safe, connected, vibrant urban roads and streets for people to live, work, move, play and stay. The guide takes a Complete Streets approach to planning, designing and delivering transport in Victoria. It puts people first, emphasizing the importance of safe access for all road users. This perspective means that safety is fundamental to any good street design. The project provides a toolbox to better understand and visualize what safe systems looks like in urban contexts and supports practitioners to implement nuanced, practical solutions.
74	Davy, S. Carslake, J. Johnson, M. Gaffney, T.	Heavy Vehicles - Trucks, Buses, Hazardous Materials Motorcyclists Bicyclists Pedestrians	Construction logistics and community safety australia (CLOCS-A): progress towards safer outcomes for vulnerable road users	Currently across Australia, \$55 billion worth of transport infrastructure projects are under development in the urban centres of major cities. These projects will significantly increase heavy vehicle movements and as a result exposure to vulnerable road user interactions raising the need for action to improve safety outcomes for vulnerable road users (VRUs). International best practice is recognised as Transport for London's (TfL) Construction and Logistics in Community Safety (CLOCS) and action is underway to adapt the CLOCS approach in Australia. This paper will present the results of the initial phase of Construction Logistics Community Safety Australia (CLOCS-A) (due to be completed in June 2020) and explore how these projects, and smaller state projects, are adapting the standards to protect vulnerable road users, where and why variances are occurring, what barriers are emerging and the path towards an Australian adapted CLOCS program.
75 (Poster)	Eramudugolla, R. Huque, M.H. Wood, J. Anstey, K.J.	Driver Psychology Older Drivers & Road Users	On-road driving errors in mild cognitive impairment	Dementia increases the risk of unsafe driving in older adults, but this is less apparent in pre-clinical stages such as mild cognitive impairment (MCI). There is a lack of detailed data on driving error patterns associated with MCI. We recruited older drivers from the community who completed a neuropsychological test battery and an on-road driving assessment. Compared to safe drivers classified as cognitively normal (CN) (n=242), safe MCI drivers (n=45) showed no difference in the rate of errors in different traffic contexts or error types. Unsafe CN drivers (n=17) made more errors in observation, speed control, lane position, and stop/give-way signs. Unsafe MCI drivers (n=9) had additional difficulties at intersections, roundabouts, and under self-navigation conditions. Unsafe drivers with MCI have difficulties under more cognitively demanding conditions, consistent with the increased rate of multi-domain type MCI found in this group.

76	Vumbaca, J. Bennett, J.M. Prabhakaran P.	Driver Psychology Young Drivers	Cognitive function and driving performance for young drivers: a systematic review and meta-analysis	Young drivers are still undergoing cognitive development at the time they begin driving. Little research synthesis on cognition and driving performance has been conducted for young drivers. A systematic review and meta-analysis on 18 studies examining cognition and driving for drivers between the ages of 15 and 25 was conducted. Results indicated a variety of cognitive domains have been examined in relation to a range of driving performance measures, however predominate focus has been on examining individual cognitive domains. Findings were varied with no single cognitive domain or test being found to consistently predict driving performance. Preliminary findings suggest that a composite approach with multiple domains might be suitable in this population to identify at risk young drivers. Similar to the older driver literature, this would allow for investigations of comprehensive cognitive models and potential applications of cognitive testing and training for young drivers to enhance safety.
77	Filardo, L. Senserrick, T. Hatfield, J. Boufous, S. Olivier, J. Fry, R. Thompson, J. Fernandes, R.	Motorcyclists Novice Driver/Rider Licensing	Evaluation of the NSW motorcycle graduated licensing scheme	The New South Wales (NSW) Motorcycle Graduated Licensing Scheme (MGLS) implemented in 2009, introduced a two-year second provisional period (P2) and extension of existing restrictions. An evaluation of the NSW MGLS consisted of a best practice review, outcome and process evaluations. The NSW MGLS was found to closely align with best practice. Comparing relevant crash trends, a number of positive findings were observed for P2 riders. However, positive outcomes were not observed in all statistical comparisons undertaken. Process evaluation showed engagement processes for training providers had improved and training was viewed positively, though not always found to be delivered consistently.
78	Yeung, M. Regan, M.A. Prabhakaran, P.	Signage & Signalisation Crossings (Pedestrian, School, Rail, Rural/Animal) Pedestrians	The relationship between pedestrian waiting times and illegal crossing behaviours at signalised intersections in the Sydney CBD.	The aim of this study was to examine the relationship between Individual Waiting Times (IWTs), Maximum Waiting Times (MWTs; imposed by the pedestrian light) and illegal crossing behaviour at nine intersection crossings in the Sydney CBD. An observational study was conducted (1.5-hours in the morning over two weeks) and validated with complementary video footage. Of the 6,931 observed pedestrians, 13.5% crossed illegally. The key finding from this study was that longer MWTs were significantly correlated with an increase in illegal crossings. The average MWTs at signalised intersections was approximately 70% longer than the average IWTs for those pedestrians that crossed illegally. The findings of research suggest that one possible mechanism to reduce illegal pedestrian crossing behaviour could be by reducing the MWT at signalised intersections.

80	Sriroongvikrai, K. Choocharukul, K.	IRAP, AusRAP, etc. Motorcyclists Pedestrians Legislation and Law	Impacts of speed limit changes on road safety risks: a case study of urban streets in Thailand	According to the WHO's Global Status Report on Road Safety, Thailand is among the top countries with highest traffic fatality rates. One contributing factor is the speed. The speed limit in Thailand is generally set at 80 km/hr for urban areas and 90 km/hr for roads outside built-up areas. Such figures are considered high and pose potential risks to road users. This study investigates potential impacts of speed limit changes. The International Road Assessment Programme (iRAP) star rating was utilized to investigate road safety in terms of risk scores for vehicle occupants, motorcyclists, and pedestrians. A total of 20 urban roads with different geometry and characteristics were selected from two cities in Thailand, namely, Bangkok and Phitsanulok. Sensitivity analysis results revealed that to achieve the target of 3-star or better roads, current speed limits need to be altered. Appropriate speed limits were also recommended for urban roads with different settings.
81	Brodie, C. Jooste, F. van der Wel, P. Tate, F.	Road Environment Policy Development And Implementation	Understanding the safety impacts and opportunities of New Zealand state highway resurfacing and renewals.	New Zealand generally experienced decreasing levels of road trauma (Deaths and Serious Injuries) up until the start of 2014, beyond which there have been four years of increases (2014-17) followed by a leveling off over the last two years. During the same period the maintenance regime, on the state highway network in particular, has also been revolutionized, with a reduced number of contracts, a change to a Network Outcomes Contract form, and a reduction, in real terms, of maintenance expenditure. This study looked to determine if there have been any changes to the state highway network condition over the last decade, if there is any relationship between those changes and road safety, and what safety outcome improvements might be possible if maintenance efforts in resurfacing and renewals was increased.
82	McLaughlin, M. McLaughlin, D. Hunt, R. Nagy, T. McLaughlin, L. Wilson, B.	Pedestrians Community Programs Road Safety Programs Education – general and other	Little Blue Dinosaur Foundation – our story – prevention through collaboration with community road safety stakeholders	Little Blue Dinosaur Foundation (LBDF) was established in 2014 in honour of Tom McLaughlin, aged 4 years who died in a pedestrian motor vehicle accident during a family holiday. In five years the Foundation have collaborated with 63 LGAs across 4 States to implement a cost effective child pedestrian road safety campaign designed to prevent trauma for very vulnerable road users. The Foundation have successfully gained five successive grants from Transport for NSW in the Community Road Safety Grant Program and campaign implementation has reached the target audience through stakeholder collaboration with Local Governments, State Governments, Police, Media, Schools and Members of Parliament. Featuring government endorsed messaging the key road safety education of the campaign aims to highlight importance of modeling safe road behaviour, working towards zero and draws on personal experiences of the impact of road trauma. Securing ongoing funding and resourcing will enable the Foundation to expand the campaign nationally.

84	Hodgson, G. McTiernan, D. Imants, P. Chevalier, A.	Crash Data Analysis Crash Data Collection	Safe system review of fatal crashes in the ACT	The ACT Justice and Community Safety Directorate engaged the Australian Road Research Board to undertake a Safe System review of ten years of fatal crashes in the ACT. The review identified common fatal crash factors across Safe System pillars (roads, speed, vehicles, people, and post-crash care) based on crash data and reports from the Australian Federal Police and Roads ACT. The method developed allowed analysis of crash factors and identification of crash patterns to determine 'gaps' in the System that likely contributed to the cause and/or severity of each crash. Using this, countermeasures were developed to address these gaps across the Safe System pillars.
86	Ponte, G. Elsegood, M Doecke, S.	Crash Data Collection Crash Data Analysis Data Linkage Ambulance and Emergency Services	Injury risk and delta-V - insights from event data recorder information and reported injury outcomes	This study examined event data recorder (EDR) information downloaded from 316 vehicles involved in crashes in South Australia from 2017 to 2019 matched to police crash reports and hospital records. The EDR vehicles contained 421 occupants and, while 70% of EDR vehicle occupants sustained no injuries, 7% percent had minor injuries, 21% of occupants were treated at hospital and 2% of occupants were admitted to hospital. Higher injury severity outcomes occurred in head-on collisions, rollovers and single vehicle collisions with fixed objects. Delta-V was a good predictor of injury, and for all crash types, an occupant in a crashed vehicle experiencing a total delta-V of 40 km/h had an injury risk of 60%, more than double the injury risk for a crash with a total delta-V of 20 km/h. In side-impact collisions, injury risk was much higher; a lateral delta-V of 40 km/h corresponded to an 87% injury risk.
88	Warner, W. Stephan, K. Newstead, S. Stephens, A. Willoughby, J. Shearer, E.	Distraction & Inattention Road Safety Programs Enforcement Technologies Statistical, Epidemiology and Other Road Safety Research Methods	Modelling the potential road trauma reductions of mobile phone detection cameras in NSW	The Road Safety Plan 2021 details the New South Wales (NSW) Government's commitment to improve road safety, including initiatives to research and enable camera-based technology to enforce mobile phone offences. In 2019 Transport for NSW (TfNSW) led a world-first non-enforcing pilot of fixed and transportable mobile phone detection cameras (MPDC), at locations across Greater Sydney. Monash University Accident Research Centre (MUARC) was engaged to estimate the potential reduction in road trauma from a proposed program of automated mobile phone enforcement. Modelling estimated that a program that reaches 99.5% of the NSW driving population and achieves 30% to 40% deterrence could prevent approximately 95 to 126 fatal and serious injury crashes over five years, equating to savings of approximately \$126 million to \$168 million. The use of overt signage highlighting camera locations would reduce the benefit of the program by around 80 per cent.

90	Elsegood, M. Mackenzie, J.	Road Design Autonomous Vehicles Computer Simulations - Restraints, Human Body, Vehicle Statistical, Epidemiology and Other Road Safety Research Methods	Determining the readiness of road line markings for autonomous vehicles through custom video analysis software	Two vehicles equipped with lane support systems (lane departure warning and lane keep assist) were instrumented with a GPS receiver and video cameras to record the detection rate of road line markings along an approximately 80 km route. Custom video analysis software was developed to determine the locations of line marking detections made by the vehicles post testing. An overall 97.8% detection rate was observed along the selected route, and the locations of the non-detections were further analysed to indicate possible causes of non-detections. Both lane support systems tested showed similar results for overall distances of line markings detected, but differences in the frequency of non-detections were reported.
92	Mackenzie, J. Ponte, G. Elsegood, M. Kloeden, C.	Speed, Speeding & Travel Speeds Road Environment Safer Transport & Mobility	A technical review of 40 km/h speed limits in the City of Charles Sturt local government area	A technical review was undertaken relating to the introduction of 40 km/h speed limits in certain areas within the City of Charles Sturt in South Australia. This involved the analysis of before and after traffic survey and crash data. Mean vehicle speeds decreased by 2.30 km/h, 85th percentile speeds decreased by 4.27 km/h, and weekday traffic volumes decreased by 7.4% in areas where the speed limits changed. Crash data was examined for equal periods before and after the 40 km/h speed limit changes and there was a 14.8% reduction in the number of casualty crashes on roads where the speed limit had been reduced from 50 km/h to 40 km/h, a 28.6% reduction in casualty crashes on roads that had a pre-existing (and retained) 40 km/h speed limit, and a 7.8% reduction in casualty crashes on Council-owned roads that retained a 50 km/h speed limit.
93	Bodzan, J. Parameswar, P. Storey, O. Dadley, D. Raisianzadeh, H. Le, J.	Intersections and Roundabouts (ITS - roads) Intelligent Transport Systems in Road Infrastructure Data Linkage Statistical, Epidemiology and Other Road Safety Research Methods	Identifying high-risk intersections by modelling driving behaviour with machine learning methodologies	Finding patterns in driver behaviour around intersections using large telematics data combined with statistical crash records in a highly accurate and predictive intersection model can enable a more preventative data driven service that saves lives. The Data Discovery Lab team within Enterprise Data and Analytics Services (EDAS), Transport for NSW recently examined the potential of using telematics data to identify high crash risk locations on NSW roads through Artificial Intelligence methodologies and Machine Learning algorithms. The methodology investigated the area in and around intersections accounting for information on driver behaviour obtained from telematics data as well as the statistical data recorded in previous years. The study has examined telematics data from 55 light vehicles, approximately 35,000 unique trips, at around 5,000 intersections and 841 crash sites in the Wollongong area. The data was pre-processed and reduced for this study.

94	Watson-Brown, N. Senserrick, T. Freeman, J. Davey, J. Scott-Parker, B.	Young Drivers Novice Driver/Rider Licensing Driver/Rider Training	Bad habits while racing to the starting line: obstacles to the development of young learner's safe driving practices	Graduated driver licensing (GDL) mandates extended supervised driving hours, providing opportunity to enhance young drivers' safe driving skills (Watson-Brown, 2020). Professional instructors provide a small proportion of on-road training compared to parents or lay supervisors; however, it is expected that they are equipped to teach the more safety-critical skills needed to reduce the high crash risk of newly independent novice drivers (Watson-Brown, 2020). This study aimed to explore the perspectives and experiences of instructors to understand the obstacles that inhibit the development of young drivers' safe driving practices as they traverse GDL. Thirteen southeast Queensland instructors were interviewed. A key finding was that instructors deal with an array of inappropriate ideation and behaviours that impacts the limited timeframe they have to focus on higher-order learnings that maximise safety and rule compliance. Learners' on-road training, as a critical element of GDL, could be improved with the integration of professional instruction and lay/parent supervision (Mayhew et al., 2017).
95	Fernandes, R. Strandroth, J. Cavallo, A. Banyer, G. Fry, R.	Road Safety Strategy Crash Data Analysis	Case-by-case analysis of current fatality trends to estimate future residual trauma in NSW	Transport for NSW is developing a roadmap for setting future road safety targets to move toward zero trauma by 2056, based on methodologies developed and applied in Sweden. Case-by-case analysis of all NSW fatalities in 2018 was conducted to forecast future trauma and safety performance, using detailed crash information as well as additional information on current and planned system improvements. Analysis shows that although the current pipeline of safety interventions in NSW will bring significant benefits they will not be enough to achieve zero fatalities in 2056 and will deliver greater benefits for vehicle occupants than for vulnerable road users. While new and innovative solutions are needed to address future residual trauma, the analysis also shows that many lives can be saved in the interim with earlier implementation of already known solutions, and by adjusting policy and delivery settings of current infrastructure and vehicle solutions to be more effective.
96	Wundersitz, L.	Distraction & Inattention Crash Data Analysis	Uncovering driver distraction and inattention in fatal and injury crashes	Driver distraction and inattention is an increasingly challenging issue for road safety worldwide. This study investigated the contribution of driver distraction and inattention within 186 fatal and injury crashes using recent in-depth road crash investigation data from South Australia, investigated 2014-2018. Using an adapted taxonomy of inattention, five subtypes of driver inattention were defined: misprioritised attention, neglected attention, cursory attention, diverted attention (distraction) and unspecified inattention. Of the 160 crashes for which there was sufficient information, 31% showed evidence of driver inattention contributing to the crash with the most common subtype of inattention being distraction (14% of all crashes). The distraction-related crashes included a variety of different distractions with those located in-vehicle the most prevalent followed by internal thoughts. Distraction from phone use was identified in 2.5% of all crashes (18% of distraction crashes). The wider context in which inattention-related crashes occurred was also examined to assist in developing system-based solutions.

98	Norberg, T.L. Radford, I. Rogers, S. Ferguson, S.	Older Drivers & Road Users Young Drivers Community Programs Education – general and other	Learner log book run and Greys driving skill enhancement run	In partnership with the Goulburn Rotary Club GMC has coordinated a successful practical learner driver Log Book Run (LBR) for six years. Community consultation identified the need to also provide assistance to older drivers resulting in the adaption of the LBR for local seniors. Both programs are designed to encourage confidence in driving while identifying areas for improvement. Along with a practical on-road component, the programs utilise a safe system approach providing education on safer vehicles, safer roads and roadside, safer speeds and safer road users. The delivery of the programs enables community groups to actively contribute to encouraging a road safety culture in their community and the involvement of the Council ensures the programs apply best-practice evidence based approaches. Both programs are vital in our local community, as they are reaching the most vulnerable road users, in an effort to foster a road safety culture.
99	Napper, R. Johnson, M. Johnston, V.	Road Design Intersections and Roundabouts Bicyclists Statistical, Epidemiology and Other Road Safety Research Methods	Safety, design and law: a new interdisciplinary approach to bicycle rider road safety	A novel problem-solving approach is demonstrated using an interaction at an intersection between a driver (turning left) and a cyclist (continuing straight). According to the road rules (RR141(2)), the bicycle rider must not to ride past on the left of a turning vehicle. However road rules and the built environment were not designed in harmony. The research hypothesis was that a new approach combining safety science, law and design were needed to approach this complex problem. The novel approach is for safety, law and design to simultaneously apply three main methods in a context of discussion. Two-dimensional drawing, three-dimensional modelling, and road rule annotation are used to represent the scenario, generate possible solutions, review, and iterate. The methods were accessible and effective for professionals from several domains.
100	Shen J. Prabhakaran, P. Bennett, J.M.	Hazard Perception	Assessing the ecological validity of button-press hazard perception tests	Hazard perception tests (HPTs) assess a driver's ability to recognise potential dangers on the road and respond appropriately. HPTs have been incorporated into numerous licensing schemes typically requiring drivers to respond to videos on a computer via a button-press. However, given drivers in reality do not respond to hazards with button-presses, the present study aimed to investigate the validity of using button-presses as a way to assess real-world hazard response behaviour. The between-subjects study, compared participant performance on a button-press HPT to accelerator and brake pedal responses to the same HPT in a driving simulator. Results revealed that response times between the button-press group and pedal-press group were significantly different in more than half the clips assessed, with the pedal-press group responding consistently faster than the button-press group, to the same hazards. The findings question the ecological validity of using button-presses to capture and translate real-world hazard response skills.

101	Mongiardini, M. Stokes, C. Woolley, J.	Speed, Speeding & Travel Speeds Road Environment Intersections and Roundabouts Signage & Signalisation	Evaluation of a warning system to reduce the risk of casualty crashes at rural junctions in South Australia	Rural Junction Activated Warning Systems (RJAWS) temporarily reduce the speed limit along the major legs of three-leg junctions when another vehicle is approaching from the minor road or turning right from the far-side leg into the minor leg. This study evaluated the RJAWS effectiveness and its potential to reduce the risk of casualties based on a trial at four rural intersections in South Australia. When the reduced speed limit signs are activated, the average travel speed along the major road is reduced between 11.3 km/h and 22.1 km/h, with a consequent reduction in the average relative casualty risk between 43% and 58%. Despite a relatively low compliance to the reduced speed limit, the RJAWS proved effective in reducing risky behaviour. When the sign was activated, the majority of drivers travelled through the intersection at speeds below the default speed limit. Extending the RJAWS program to additional intersections is strongly suggested.
104	Bodzan, J. Storey, O. Shaz, K. Wright, C. Ledger, S. McCaffery, T. Wall, J. Chevalier, A.	Data Linkage Statistical, Epidemiology and Other Road Safety Research Methods	A methodological approach to reducing connected vehicle data	The second stage of Transport for NSW's Cooperative Intelligent Transport Initiative (CITI) collected high volumes of raw in-vehicle data from 55 privately-owned light vehicles fitted with trial equipment over a ten-month period. Data were collected from two different devices fitted to participants' vehicles. The cooperative intelligent transport system (CITS) recorded data transmitted and received at 10 Hz (up to 10 datapoints per second) while a telematics device recorded data at 40 Hz (up to 40 datapoints per second). It was essential to translate the hundreds of millions of data records into a more concise format to address research questions. This presentation addresses the intricacy required to reduce the data to engineer analytical datasets, reducing noise in the data and producing a range of summary datasets, maintaining quality outcomes to allow the investigation of road safety benefits and limitations of the CITS alerts.
105	Mulvihill, C. Horberry, T. Fitzharris, M. Lawrence, B. Schnittker, R. Lenné, M. Kuo, J. Wood, D.	Distraction & Inattention	Evaluation of a prototype driver distraction human-machine interface warning system	Recent advances in vehicle technology permit the real-time monitoring of driver state to reduce fatigue and distraction related crashes, particularly within the heavy vehicle industry. Relatively little published research has evaluated the human machine interface (HMI) design for these systems. However, the efficacy of in-vehicle technology depends in part on the usability and acceptability among drivers of the system's interface. The HMI of a prototype multi-modal warning system developed by the authors for driver distraction was evaluated in a truck simulator with eight car and six truck drivers using the System Acceptability Scale, comprehension and open questions. The results showed that all participants perceived the system as acceptable and useful, and that the warning modalities (visual, auditory and tactile) were largely understood correctly and perceived to be effective. This study identified no major design flaws with the recently developed HMI, but on-road evaluations are recommended to validate these findings.

106	Timms, M.	Motorcyclists Workplace and Work Related Road Safety General Enforcement	Towards zero: safety testing of police motorcycle jackets	By 2019, New South Wales Police Force (NSWPF) operated a motorcycle fleet of 120 road bikes. With riders increasingly exposed to all weather and road conditions, Traffic and Highway Patrol Command (THPC) commenced a search for high-visibility summer and winter motorcycle jackets that could provide improved safety and comfort. The timing of the project coincided with the establishment by Australian and New Zealand road safety agencies of the Motorcycle Clothing Assessment Program (MotoCAP), a world-first rating system for motorcycle clothing. THPC partnered with Deakin University to subject prospective jackets to the MotoCAP testing protocol and worked with a clothing manufacturer to build additional safety into their products. This combination of road safety/safe systems methodology and work health safety (WHS) due diligence represents a fresh approach to the procurement of uniform for organisations that operate motorcycles, as well as the manufacturers who supply that clothing.
107	Ledger, S.A. Chevalier, A. Hillier, P. Chircop, D.	Temporary Road Works Workplace and Work Related Road Safety Crash Data Analysis	Analysis of rear-end and other crashes related to roadwork sites in NSW	Transport for NSW (TfNSW) commissioned the Australian Road Research Board (ARRB) to conduct a systematic analysis of rear-end crashes (and other crash types) in NSW to identify key reported contributing factors to reduce their frequency and impact. The review analysed 118,628 crashes recorded in the CrashLink database reported in 5-years 2013 to 2017. Data were analysed by examining count data, percentages and cross-tabulations across a number of levels of analysis by crash location and crash type. Of all reported crashes, 1.43% (1693/118628) were related to roadwork zones and 40.3% of these (682/1693) were rear-end crashes. Rear-end crashes were more likely to be related to roadwork zones compared to non-rear-end crashes. Roadwork zone crashes tended to have more severe outcomes on rural roads, with heavy vehicles as the key traffic unit. One in five rear-end roadwork zone crashes involved distraction. These findings may assist when considering implementing countermeasures to reduce the likelihood of rear-end crashes related to roadwork zones.
109	Senserrick, T. Watson-Brown, N. Buckley, L. Watson, B. Scott-Parker, B.	Speed, Speeding & Travel Speeds Young Drivers Driver/Rider Training	Young Novice Drivers' Speed Management: A Systematic Review	Excessive speed is a persistent contributor to road trauma, with this risk exacerbated by youth and inexperience. This research aimed to systematically review literature on contributing factors to young driver travel speeds. Searches of key databases for research published between January 2009 to June 2021 yielded over 2,000 records. Of 167 full paper reviews, 46 intervention and 54 studies of individual characteristics and situational vehicle, road environment, performance and behavioural factors were included. The findings provide insights into potential fresh approaches to education on speed management when learning to drive, additional to the current stronger focus on volitional speed behaviour.

110	Milling, D.	Motorcyclists Road Environment Road Safety Audit and Road Safety Review Road Safety Barriers	Guidelines to provide roadside protection for motorcyclists	Currently in Australia Guidelines are not published to assist in identifying when safety barriers should be provided to protect motorcyclists from unforgiving roadsides. This includes guidance for the installation layout and lengths of a motorcycle-friendly barrier. Some approaches for identifying when to provide treatments include consideration of Black Spots, Black Lengths or routes with high motorcycle volumes. These approaches do not always result in the highest risk locations being treated additionally, the design and installation of protection is likely to vary. A proactive, warrant based approach is required to identify when to provide roadside protection for motorcyclists. Guidelines defining a Motorcycle Protection System (MPS), identifying and prioritising where to install MPS's, and how to determine the layout and length of MPS has been developed. These guidelines will allow for MPS's to be proactively installed, contributing to providing safer roadsides for motorcyclists and reducing the crash severity of motorcycle run-off-road crashes.
111	Przibella, S. Porter, L. Hooper, C. Rowland, M. Hall, P. Røhl, A. Kvist, S. Dockstader, C.	Road Environment Road Design Bicyclists Land Use & Urban Planning	Complete streets Victoria: the cycling guide	During 2019 and 2020 the Department of Transport with consultants Arup and Gehl are developing a design guide for cycling as transport in Victoria. The Cycling Guide is the first of a suite of modal-specific guides to support Complete Streets Victoria, an urban roads and streets design guide. This project represents a Victorian-first approach to design and planning cycling infrastructure that will empower and encourage practitioners to raise the standard of the Victorian cycling network and create safer outcomes for people who ride. The project takes a new safety-first, user-focused approach that captures whole of trip considerations. It provides strategic and technical guidance underpinned by safe systems to give practitioners confidence to implement safer more inclusive infrastructure.
114	Howe, M. Mackenzie, J. Reid, I.	Road Design Intersections and Roundabouts IRAP, AusRAP, etc. (ITS - roads) Intelligent Transport Systems in Road Infrastructure	What computer vision can tell us about road safety?	Aims to reduce fatalities on city roads by 2030 and within Australia by 2050 have been set but current methods to evaluate and validate safety through crash data do not allow for fast development cycles, often taking years to collect statistically representative data. If these aims are to be met, new methods of safety evaluation must be utilised to decrease the evaluation and validation cycle. Computer vision (CV) has recently become a viable technology for use in this area with its ability to extract a range of road user characteristics. This research explores previous safety research using CV, the current limitations of CV systems, and the next advancements of CV that could give new, exciting tools for evaluating safety. Also presented is a CV system capable of extracting road user characteristics for road safety studies and to build upon with new CV techniques.

115	Stokes, C. Moon, W. Johnson, J. Woolley, J.	Education – general and other	Safe system for universities: safe system education for tertiary engineering students update	Safe System represents long-established best-practice in road safety internationally and in Australia and New Zealand. However, there has been limited success implementing Safe System policy into practice. While Safe System theory is taught at some Australian universities, there are currently no consistent means of formal education before professionals enter the workforce, leading to a discrepancy between graduate engineer knowledge and industry best-practice. Here, we present an update to the Safe System for Universities (SS4U) project, which provides a means for consistent education of Safe System theory at a tertiary level.
118	Chircop, D. Hodgson, G. Hillier, P. Chevalier, A.	Data Linkage Driver Risk Road Safety Audit and Road Safety Review Temporary Road Works	Evaluation of yellow line marking and variable speed limit signs to improve safety in roadwork zones in NSW	To improve safety outcomes for road users and workers Yellow Line Marking (YLM) and Variable Speed Limit Signs (VSLS) were trialed with existing traffic controls in NSW roadwork zones. TfNSW commissioned ARRB to evaluate these initiatives by synthesising the findings from a variety of documents, data and other field based evaluations to determine if these initiatives should be deployed on an ongoing basis. For YLM, the positive safety benefits appear to be outweighed by the costs to implement and effort required to maintain. Additional robust evaluation and evidence would be required to quantify its benefits and justify implementation. VSLS benefits were more apparent, including the impact on driver adherence to speed limits, improved driver attention and reduced safety risk for workers. There seems to be value in continuing its use under controlled conditions to assess ongoing impacts. This evaluation approach could be applied by other organisation's evaluating traffic control initiatives.
119	Cosgrove, L.	Community Programs Early Childhood Road Safety Road Safety Programs	Responsivity and innovation in road safety education: are we listening to our audience?	As part of Transport for NSW's (TfNSW) Road Safety Education Program, <i>Kids and Traffic</i> works with early childhood organisations to support families and communities to improve safety outcomes for children. Ongoing engagement with early childhood and other key stakeholders enables responsive, evolving and strategic delivery of the Program within a double loop learning framework, driving creativity and innovation (Synnott, 2013). Evidence-informed responsivity to emerging social and educational trends and the needs and interests of stakeholders ensures <i>Kids and Traffic</i> maintains its relevance and position as a valued, trusted provider of road safety education professional learning and resources. Initiatives that address barriers to engaging early childhood services, families and communities in road safety education increase Program reach and effectiveness. Development of innovative approaches to road safety education which respond to the needs and interests of stakeholders supports the Program's goal of zero child road trauma.

120 (also Full Paper)	Budd, L. Newstead, S.	Vehicle Crashworthiness Crash Avoidance and Crash Severity Reduction Pedestrians Policy Development And Implementation	Future light vehicle safety priority areas in Australia	This analysis aimed to identify future priority action areas for light vehicle safety by identifying fatal crash types that will not be fully addressed in the future by projected improvements in active and passive safety in the light vehicle fleet. Modelling the likely future crash profile of the light vehicle fleet in Australia identifies target areas for future vehicle design and technology improvements that will assist in achieving the goals of Towards Zero. Analysis identified four priority areas: (i) fatal pedestrian crashes, (ii) single vehicle frontal crashes with fixed objects, (iii) front-to-front vehicle crashes and (iv) front-to-side impacts, including straight crossing path and right turn across path crash types. Suggested countermeasures include the investigation mechanisms to improve the natural penetration of key driver assist technologies, particularly in light commercial vehicles, as well as new or enhanced technologies targeting crashes involving intersections, speeding, fatigue, distraction, pedestrians and bicycles.  (See also: <a href="https://doi.org/10.33492/JRS-D-21-00001">https://doi.org/10.33492/JRS-D-21-00001</a> )
122	Baldock, M. Lindsay, T.	Drink Driving Drug Driving Drug Testing	Characteristics of crash-involved drink and drug drivers and motorcyclists	This study examined the characteristics of 1,277 hospitalised road users in South Australia in the years 2014 to 2017, with reference whether they tested positive to alcohol or other drugs (the three drugs prescribed in the South Australian <i>Road Traffic Act (1961)</i> : THC, methamphetamine, and MDMA). This examination used a database combining hospital data, police-reported crash data, licensing information, and the result of alcohol and drug tests conducted by Forensic Science SA. Findings include: that those combining drugs and alcohol only comprise a small proportion of hospitalised motorists; that drivers are more likely to test positive to alcohol or methamphetamine, while motorcyclists are more likely to test positive to THC; drug and alcohol positive motorists tend to exhibit a range of other risky behaviours, and also tend to sustain more severe injuries in the event of a crash.
123	Wilson-Ridley, J.E. Woods, J. McAdie, S. Norberg, T. McDougall, K.	Distraction & Inattention Motorcyclists Road Safety Programs Education – general and other	Joe Rider motorcycle safety campaign – cross-border road safety cooperation and implementation into local government regions	In 2016, QPRC first partnered with ACT Motorcycle Rider Association (MRA) to extend their 'Joe Rider' Motorcycle Safety Campaign into NSW regions. Adapted for local implementation with three local governments the project featured targeted strategies to local motorists about risks for motorcycle riders while encouraging local riders to ride safely. The campaign builds on 'Look but failed to see' crash research and aims to positively support riding in the region through increased awareness. From a successful pilot, the project was incorporated into QPRC Road Safety Action Plan and delivered annually from 2017-2020 involving stakeholder involvement of local rider trainers Stay Upright and Australia Post. Fostering ongoing cross-border collaborations the project capitalizes on region-wide impact of a shared approach while benefiting from local implementation. While there are challenges to cross-border collaborations the benefits have been realized through increased reach and participation from local motorists on each successive implementation of the campaign

124	Martin, L. Turner, S.	Pedestrians Signage & Signalisation	Pedestrian safety at traffic signals	While traffic signals are relatively safe for pedestrians (compared with other intersection forms of control and mid-blocks) there are still a significant number of fatal and serious crashes at these intersections in New Zealand. It is challenging to achieve safe system at such intersections given most are located on arterial roads and therefore have a 'traffic movement' function. Lower speed limits to achieve operating speeds of 30km/h or less are not always viable at these intersections except where there is also a high place-making function, such as CBDs and larger activity centres. Severe pedestrian crashes at traffic signals are often a result of either a pedestrian or a driver not obeying the signal phasing. This is especially the cases when a pedestrian is being struck by a vehicle traveling straight through the intersection (either at the pedestrian crossing or on the intersection approach). To address these crashes, it is important to understand the factors, including behaviours, behind jaywalking and red light running. These factors vary from intersection to intersection and by time of day. A better understanding of these factors will assist in reducing road trauma.
125	Sivasankaran, S.K. Rangam, H. Balasubramanian, V.	Crash Avoidance and Crash Severity Reduction Motorcyclists Statistical, Epidemiology and Other Road Safety Research Methods Post Crash Rehabilitation	Epidemiology and injury profiles of single vehicle motorcycle fatalities in Tamil Nadu, India, 2009-2017.	Single-vehicle crashes which do not collide with other vehicle or pedestrians which are involved in an accident due to causes such as self skidding, hitting stationary objects, trees which is simply contributed by the drivers themselves. Such type of accidents which are contributed by the drivers themselves. single-vehicle crashes account for a large proportion of fatal accidents. In India, a significant proportion of accidents are single-vehicle motorcycle crashes. Extensive research has been carried out to investigate the risk factors and patterns associated with single-vehicle motorcycle crashes. All the motorcycle crashes reported from 2009 to 2017 which resulted in fatalities among which single-vehicle crashes alone were extracted from the database. Analysis of injury information identified in single-vehicle crashes, motorcyclist's most commonly sustained head injuries (51.27%). Injuries to the multiple body parts (20.13%), leg (3.26%) and hand (3.18%) were also commonly reported. Further investigation is required to develop effective countermeasures for reducing fatalities.

126	Sivasankaran, S.K. Rangam, H. Balasubramanian, V.	Road Environment Crash Avoidance and Crash Severity Reduction Crash Data Analysis Statistical, Epidemiology and Other Road Safety Research Methods	Analysis of injury severity in single-vehicle four- wheeler crashes with drivers being at-fault in Tamil Nadu, India.	Single-vehicle crashes are of major concern in both developed as well as developing nations due to the severity of injuries it results in. Several studies in the past have highlighted that single-vehicle crashes account for a large proportion of fatal accidents. In India, a significant proportion of accidents are single-vehicle crashes. According to the report by the Ministry of Road Transport and Highways (MoRTH, 2018), a total of 4,67,044 accidents have been reported by the states and union territories in which have claimed 1,51,417 lives. However, a clearer picture with respect to single-vehicle crashes is unavailable. Single-vehicle crashes are generally classified into two types: one in which the vehicle collides with the pedestrians and the other where the vehicle does not collide with other road users. The vehicles which do not collide with other vehicle or pedestrians which are involved in an accident due to causes such as self skidding, hitting stationary objects, trees which is simply contributed by the drivers themselves. Such type of accidents which are contributed by the drivers themselves is referred to as out-of-control single-vehicle crashes. The influence of roadway and environmental factors play a major role in these crashes. The objective of the present study is to obtain a clearer understanding with respect to the injury severity of the out-of-control single-vehicle four-wheeler crashes with the drivers being at fault. Contributory factors including driver, roadway, and environmental characteristics are investigated and discussed.
127	Rangam, H. Sivasankaran, S.K. Balasubramanian, V.	Heavy Vehicles - Trucks, Buses, Hazardous Materials Crash Data Analysis Statistical, Epidemiology and Other Road Safety Research Methods Ambulance and Emergency Services	Investigation of injury patterns in heavy-duty single vehicle crashes based on real-world accident data in Tamilnadu, India	Heavy-duty vehicles serve a vital function in any of the developing economies. In India, heavy-duty vehicles are defined as vehicles with gross vehicle weight over 11,793 kgs. These vehicles include bus, truck, tractor, and heavy articulated vehicle/trolleys. In recent years, there has been an interesting interest in studying the contributory factors for single-vehicle crashes especially that of heavy-duty vehicles. Single-vehicle crashes are those crashes where vehicles do not collide with other vehicles or pedestrians, but due to causes such as self skidding, hitting stationary objects, trees which are simply contributed by the drivers themselves. Descriptive statistical analysis has been carried out. The dataset was obtained from RADMS database where 4983 crashes were identified to be heavy-duty single-vehicle crashes. Analysis of injury descriptors in heavy-duty single-vehicle crashes showed that drivers most commonly sustained multiple injuries (13.2%) to various body parts followed by head injuries (12.2%) and hand injuries (2.6%). Further investigations are required.

129	Warren, J. McCreanor, V. Cameron, C. Vallmuur, K. Pollard, C. Hope, M.	Data Linkage Statistical, Epidemiology and Other Road Safety Research Methods Emergency Hospital Trauma	The risk and cost of pelvic and lower limb fractures from road transport crashes: Motorcyclists are key	Pelvic and lower limb fractures from road transport crashes (RTCs) form a considerable proportion of the trauma related workload in acute care settings and is an area of focus, not only for the health care sector, but for road safety. Post-crash analysis of linked Queensland hospitalisation data was undertaken to calculate the risk and cost of acute treatment, in addition to the risk and cost of hospital readmissions 12 months post injury, by road user group (car occupants, motorcyclists and cyclists). Risk of hospitalisation was 26 times higher for motorcyclists than car occupants, with hospitalisation costs being \$80 per registered motorcycle, compared to \$4 per registered car. Over 24% of injured motorcyclists are readmitted within 12 months; this is 28% higher than car occupants. Data linkage is crucial for providing a more comprehensive profile of hospital utilisation and associated costs beyond initial acute treatment.
131	Terranova, P. Dean, M. Piantini, S. Fitzharris, M. Gabler, H.C. Savino, G.	Crash Avoidance and Crash Severity Reduction Crash Data Analysis Motorcyclists Scooters	Motorcycle active safety systems: a cross-national comparison of applicability in the Australian, Italian, and US fleets	Motorcycle-based active safety systems, e.g. antilock braking, motorcycle automatic emergency braking, collision warning, curve warning, and curve assist, have great promise to avoid or mitigate many of the crashes suffered by powered two wheel (PTW) riders. Earlier studies have examined the applicability of these systems to individual crash types, e.g. rear-end vs intersection crashes, as a means of prioritizing active safety systems development. However, there may be large regional differences in the distributions of PTW crash type, motorcycle type, and road systems, and hence in the priority for development of systems. The study objective is to compare the applicability of active safety for motorcycles in Australia, Italy, and the US using police-reported crash data from each region. The analysis found stark differences in the expected applicability of active safety systems across the three regions. This has important implications for regulators, and may require country- specific minimum performance requirements for PTW active safety countermeasures.
133	Taylor, M. Taneja, S. Tofa, M. Hope, G.	Driver Psychology Hazard Perception	Floodwater on roads: driver behaviour and decision-making	In Australia, vehicle-related flood fatalities represent a large proportion of all flood deaths. Fitzgerald et al. (2010) and Hamilton et al. (2016) found that driving into floodwater accounts for 48.5% and 53%, respectively, of flood-related drowning deaths in Australia. However, little is known about the frequency and circumstances in which Australian drivers enter floodwater. Here we report the findings of a nationally representative survey (n=2104) that explores driver behaviour and decision-making around water on roads. We present a statistical analysis of drivers who have entered floodwater to identify the characteristics of drivers who are more likely to enter floodwater, and an analysis of the situational factors and influences on decision-making when drivers attempt to drive through floodwater. Lastly, we explore the implications of these findings for road safety, flood risk communication, and driver education.

134	Phan, D.C. Truong, L. Nguyen, H.D. Tay, R.	Road Safety Strategy Land Use & Urban Planning Safer Transport & Mobility Crash Data Analysis	Can walking and cycling for train access improve road safety?	This paper investigates the impacts of train commuters' access modes on road safety at a network-wide level, using a case study in Victoria, Australia. Crash and census data were aggregated at the Statistical Area Level 1 (SA1) for the analysis. Results of negative binomial regression models illustrate positive effects of using train for commuting, either with walking or car access modes, on reducing both total crashes and severe crashes. The safety effects of commuting by train with the cycling access mode appear to be positive, which however were not statistically significant.
135	Yunos, M.N.M. Hakendorf, P. Adey-Wakeling, Zoe	Statistical, Epidemiology and Other Road Safety Research Methods Post Crash Rehabilitation	Agreement on fitness to drive outcome between rehabilitation medicine physician prediction and occupational therapy on-road assessment	Assessment of fitness to drive is a complex and ideally multidisciplinary process, with no defined gold standard of assessment. This prospective audit investigates the agreement on fitness to drive outcome between Rehabilitation Medicine Physician (RMP) prediction and occupational therapy (OT) on-road assessment results in 242 patients across a 4 year period. Prediction is based on history, collateral history, screening assessments and clinical judgement of a doctor experienced in driving assessment. Objective practical on-road assessments are completed by a driver-trained occupational therapist. Correlation is further assessed for subcategories of cognition and assessment for vehicle modification. The percentage of agreement was 88.6% with slight agreement (weighted kappa 0.25) between the RMP and OT on-road outcome. The percentage of agreement was greatest (91.4; weighted kappa 0.3) for patients that required modification assessment, and lowest (85.7%, weighted kappa 0.24) for patients undergoing assessment for cognitive indications. This study demonstrates higher level of correlation for clients undergoing assessment for physical limitations, with prediction of impact of cognition on driving performance evidenced as more challenging. Occupational therapy on-road assessment is therefore a pivotal assessment tool to ensure maximization of both maintenance of client independence, and identification of at-risk clients.
137	Frost, F. Faulks, I.	Distraction & Inattention Enforcement Programs Enforcement Technologies	Snap-chat – mobile phone camera enforcement and community attitudes	The introduction of mobile phone detection cameras in NSW is a world-first program to target phone use while driving, a critical aspect of distracted driving. Monitoring community attitudes to this new enforcement is important, as insights gained can be used to adapt and develop policy. The study reported here, when completed, will provide a series of snap shots of community views over the period of the introduction and deployment of mobile phone cameras. Early indications from the data show that there is strong community support for the new enforcement program, with a shift in drivers' perceptions towards an increased likelihood of being caught for a mobile phone offence. There is concern that the demerit point penalty for the offence is too harsh, although the fine penalty is accepted. It is anticipated that the mobile phone camera enforcement program will result in a positive change in driver behaviour.

140	Meyer, D. Muir, S. Slikboer, R. Silva, S. Imberger, K. McIntyre, A. Pyta, V.	Driver Risk Statistical, Epidemiology and Other Road Safety Research Methods	Modelling the relationship between driver history and crash risk	The objective of this study was to determine if offence history can be used to predict future Fatal and Serious Injury (FSI) crash involvement. Using data extracted from Victoria's Road Crash Information System and Driver Licensing System, statistical models for future FSI crash involvement were developed using machine learning methods. Models were produced for a general sample (representative of the general population) and five subgroups (probationary, older, heavy vehicle, motorcycle and banned drivers). The accuracy of models improved when offence history variables were included with demographic and licensing variables. Speeding, seatbelt and traffic light offences and driving bans were important predictors for future FSI crash involvement in the general sample. Total number of recent offences and traffic infringement notices (TINs) were important predictors for future FSI crash involvement for the subgroups.
141	Olivier, J. Laolert, P.	Bicyclists Legislation and Law Personal Protection – Helmets, Clothing, etc. Statistical, Epidemiology and Other Road Safety Research Methods	Does biomechanical and epidemiological evidence of bicycle helmet effectiveness translate to a population?	Many studies have found bicycle helmets reduce the risk of head injury following a crash or fall. Some argue these do not translate to a population reduction in cycling head injury. This is often due to a lack of relevant data prior to helmet promotion and/or legislation. Western Australia introduced bicycle helmet legislation on January 1992 and, unlike other Australian states, has electronic hospital records from the early 1970's. Using an interrupted time series approach, the rate of serious head injury per 100,000 were compared following helmet promotion from the mid-1980's and helmet legislation in 1992. Serious head injury among cyclists were increasing prior to helmet promotion or legislation but reduced by a combined 63% by 1993. This reduction coincided with large increases in helmet wearing in WA across all-ages.
142 (Poster)	Bartels, J. Mestroni, K. Plant, B.	Young Drivers Driver/Rider Training	Supervised practice hours among older novice drivers in Victoria: stakeholder perceptions and readiness to obtain supervised driving practice	There is no requirement in Victoria for learner drivers older than 21 years to complete supervised driving practice before sitting the drive test. This research sought to understand stakeholders' views about the value of supervised driving experience for learners over 21 and the willingness of older novice drivers' to complete supervised practice hours. Focus groups and interviews with novice drivers, licence testing officers, and driving instructors (Study 1) showed agreement that supervised driving experience for older novices may result in better, safer drivers. An online survey with older novice drivers (N = 968) (Study 2) revealed approximately one third had completed at least 80 hours of supervised practice; the remainder reported they would be willing to complete 72.25 hours (SD = 33.60) before sitting the drive test. Improving access to supervisors could help to increase the number of practice hours that older novice drivers in Victoria complete.

148	Wood, J. Brough, D. King, M. King, N. Bentley, L.A. Fylan, F. Black, A.A.	Pedestrians	Making nighttime pedestrians safer using innovative clothing designs	Nighttime pedestrians are at significant risk of being killed or seriously injured, because drivers often fail to see them in time to avoid a collision. Clothing incorporating retroreflective markers on the moveable joints creates a visual perception of 'biomotion' and improves nighttime pedestrian conspicuity. This study investigated whether biomotion-enhanced clothing retains its conspicuity if adapted to make it more acceptable to wear. In a nighttime closed road study, we compared the relative conspicuity of pedestrians to young drivers with normal vision when pedestrians wore biomotion strips of different thicknesses and patterns versus other typical clothing worn by nighttime pedestrians. Results showed that all the biomotion clothing resulted in significantly longer conspicuity distances than sports, fluorescent yellow or black clothing (4x longer distances than black clothing). These effects were evident regardless of pedestrian orientation and have implications for the design of clothing for walkers and runners to enhance their nighttime safety.
150	Gardener, R. Janssen, K. Caen, A. Soni, S.	Road Environment Financing Road Safety Crash Data Analysis Data Linkage	Developing a Geo Artificial Intelligence Process to Assist with Programme Evaluation	Every year in New Zealand (NZ), more than 150 people are killed or seriously injured on curves on roads in the rural network. In fact, approximately 95% more injury crashes occur on curves classified as high-risk (Abley, 2017). A GIS mapping tool was developed to identify high-risk out-of-context curves and an evaluation commissioned to measure its success. Identifying the extent of curve improvements across NZ over a 3-year period was a daunting proposition. A fresh approach to engineering project evaluation was required - one that didn't involve systematic investigation of all separate engineering works completed and all speed limit changes gazetted. This paper discusses the journey to developing an automated intelligence process for evaluating out-of-context curve improvements on State Highways (SH) and the subsequent expansion of the process for high-risk curves on the local roads network.
151	Bartels, J. Leckel, J.	Pedestrians	Pedestrian road safety project	The Department of Transport commenced a review of pedestrian road safety to provide a deeper understanding of the factors relating to pedestrian crashes, the road safety benefits of pedestrian related rules as well community understanding and compliance with current rules. Activities include undertaking a legislative review of the Victorian Road Safety Road Rules (2017); analysis of pedestrian crash data to determine trends, patterns and causes of crashes, and how these may relate to compliance/knowledge of road rules; stakeholder and community consultation on the road safety benefits, challenges and issues for pedestrians and how they are affected by infrastructure, education and regulatory compliance. Results to date highlight the Road Rules are complex and have strengths and weaknesses. Results also show crashes involving pedestrians mostly take place when crossing the road and old and young pedestrians are more vulnerable. Community and stakeholder perceptions will be shared once engagement is completed.

152	Lamond, R.	(ITS - vehicles) Intelligent Transport Systems in Vehicles Speed, Speeding & Travel Speeds Workplace and Work Related Road Safety	Assessment of CSG operator driving related transport incidents and impact of implementing in vehicle monitoring systems (IVMS) on incident frequency.	Previous research has highlighted that work-related road safety is an area that requires further attention with a focus on developing research informed interventions aimed at producing significant cost and efficiency savings to industry, whilst in parallel improving road safety outcomes for workers and community. The implementation of In Vehicle Monitoring Systems (IVMS) is one such intervention. Origin Energy installed IVMS in their vehicle fleet in 2011 (2010: 4,849,000 km driven by 231 vehicles) to assist in the reduction of work related road incidents. This study reviews the impact that decision had on incident frequency. Road related incident frequency rates were reduced by approximately 60% since the implementation of IVMS in 2011 (Ratio Rate = 0.395, CI 0.230 to 0.721). The study makes recommendations for further analysis of work-related driving incidents to better understand driving behaviour and to establish a cost-benefit relationship for intelligent transport systems (ITS) such as IVMS.
153	Lambrinos, A.	Road Environment Fleet Safety Safer Transport & Mobility Road Safety Programs	Transurban Queensland motorbike incident response trial	Recognising the risk to drivers involved in a road incident and the challenges of responding in peak times, Transurban Queensland launched an Australian first Incident Response Motorbike trial in late 2018. The aim of the trial was to improve initial on scene response times and clearance times, to reduce congestion around incidents and improve the performance and reliability of the road network and safety of all motorists. The motorcycles have demonstrated an important use in getting through congestion sooner than other vehicles and provide basic support to motorists including fuel and water. At the same time making an assessment to ensure the response team know exactly what is happening at the scene. This presentation will focus on the significant safety benefits that have resulted from the trial – including reduced clearance and response times and the impact this has on motorists in the event of a breakdown or incident.
156 (Poster)	Blackman, R. Wilson, A.	Motorcyclists	Motorcycle choice and self-reported crashes of Queensland motorcyclists	Research has explored relationships between crash involvement and motorcycle characteristics, including engine capacity, motorcycle type and power-to-weight ratio. The current research continues this path, focusing on results of a Queensland rider Survey in 2017-2018. The survey attracted 1290 valid responses from fully licensed riders (71%), restricted licence holders (26%) and learner riders (3%). Types of motorcycle reportedly ridden most frequently included Sport/Naked sport (52%), Cruiser (18%), Adventure (9%) Sport-touring (7%), Trail and Enduro (4%) and Touring (3%). An on-road crash in the past three years was reported by 21% of participants, with statistically significant differences by motorcycle type ( $p = .019$ ). Riders of Trail and Enduro motorcycles were most likely to report a crash (32.7%), followed by Adventure (27.1%), and Sport/Naked sport (24.6%) types. Cruiser riders were least likely to report crash involvement (14.8%). Crash involvement by motorcycle power-to-weight group showed no statistically significant results.

157	Sultani, M.	Road Design Intersections and Roundabouts Road Safety Audit and Road Safety Review Policy Development And Implementation	Developing a black spot investigation program for Kabul city roads	With a rough data available, around 5230 people is estimated to die on the roads annually that is 15.1 people per every 100,000 populations in Afghanistan (Organization, 2018). Kabul city with around 5 million residents deals with serious road safety challenges, still there is not developed a black spot investigation program, this research investigated five major black spots in Kabul city. A rough crash data from traffic department show that five roads are the black major spots. To determine the exact spots, site visits were conducted, measuring speed, observing road users' behaviors and the road environment. The major concerning reasons were investigated. Speeding was a major factor of crashes on curves, two ways stop control at major intersections were the main factor of crashes. It concluded that speed reduction measures taken, pedestrian bridges built, and the intersections transformed to signalized with some geometric changes.
158	Di Stefano, M. Landgren, F. Mestroni, K. Cruise, B.	Road User Behaviour and Human Factors Medical and Post Crash Care	Medical fitness to drive: development of transport and medical practitioner partnership to enhance road safety	Drivers with medical conditions and disabilities represent a significant proportion of our driving community. During 2017, several coroner reports on deaths without inquest involving drivers with established medical conditions triggered the need for closer collaboration with peak medical bodies to understand medical fitness to drive issues, medical review processes and road safety risks. We applied an evidence based and action research approach involving participant engagement at every stage to interrogate the issues. The expert action group guided discovery work, a systematic literature review and countermeasure investigations. Despite national medical fitness to drive (FTD) guidelines (available since 1998), we identified gaps in medical practitioner knowledge and skills, low driver awareness and other systems factors. The group committed to a further three year term to continue delivering FTD outcomes demonstrating true application of across domain collaboration to achieve road safety benefits – as reflected by "Towards Zero – A Fresh Approach".
160	Liersch, C.	Vehicle Crashworthiness Crash Avoidance and Crash Severity Reduction Restraints	Bus passenger protection – are we there yet? After 30 years what are the new challenges to bus safety.	Bus Safety has taken enormous strides forward in the last thirty years. Road infrastructure has improved on many highways to reduce the likelihood of a bus "run-off road" or bus to vehicle crash. Vehicle technology has improved with increased safety features included in bus specifications. Driver training and driving regimes have been revamped to reduce driver fatigue. Additionally bus seating with integrated safety belts have been introduced. But are we at risk of losing some of what we have gained through the fast-paced change in Bus manufacturing and the components used within such vehicles? This paper reflects on the past, and the many improvements made over the last three decades. It also examines some potential risks manifesting themselves within the bus industry and includes suggestions as to what we may be able to do to avoid losing some of the great gains that have been achieved in recent years.

163	Elsegood, M. Doecke, S. Ponte, G.	Speed, Speeding & Travel Speeds Crash Data Collection Crash Data Analysis Data Linkage	Speeding insights from the CASR EDR study	Travel speed data retrieved from vehicles with event data recorders (EDR) were matched to police reports and hospital records, allowing insight into driver behaviours. Details of 316 cases were collected and categorised into crash types and movement groups. Vehicles travelling at self-selected, unhindered, free speeds immediately preceding the crashes were shown to be speeding in 36.1% of cases. Males were shown to have a slightly higher proportion of speeding from the sample, but speeding was shown to be statistically significantly more prevalent with drivers aged below 40 years old.
164	Di Stefano, M. Landgren, F. Ross, P. Townsend, T.	Road User Behaviour and Human Factors Vulnerable Road User Safety	Motorised mobility device use: consensus based non-regulatory countermeasures to enhance user road safety	Motorised Mobility Devices (MMDs) including powered wheelchairs may enable people with limited walking capacity to enhance community participation, however user safety is a consideration. Rider licensing and MMD registration processes are unsuitable considering the health systems context of MMD procurement and use. MMD users present with differing impairment states requiring a health framework approach encompassing user suitability assessment, MMD prescription and training, and ongoing review. These processes have the potential to underpin and enhance safety on our road system, addressing Pillar 4 (Safer road users) of the UN Decade of Action for Road Safety Global Plan and contributing to 'Towards Zero' goals. Following a literature review and stakeholder consultation, we identified gaps in resources and tools to support evidence based assessment, prescription and review processes considering safe system principles. Using action research approaches and targeted surveys, we established content validity for tools and resources ready for trialling by health practitioners.

166	<p>Aggrey, S. Ssentongo, B. Kato, A. Onyuth, H. Mutekanga, D. Ongom, I. Aryampika, E. Lukwa, A.T.</p>	Road Safety in Developing Countries	Perceived factors associated with boda-boda (motorcycle) accidents in Kampala, Uganda	<p>According to the United Nations, nearly 1.25 million people are killed and up to 50 million people are injured on the world's roads every year. Uganda loses about 10 people daily to road accidents, costing about US\$1.2 billion annually which represents about 5% of the GDP. The objective of this study was to identify causal factors that can be associated with boda-boda accidents in Uganda. A cross sectional study assessed 200 boda-boda riders in the urban areas of Kampala, Uganda. Interviews using semi-structured questionnaires were administered to all participants. Data collected was entered in excel and imported to STATA for analysis. Multivariate and bivariate analyses were conducted to determine factors that influenced accident risk perception. All variables which were significant at bivariate level and thought to be theoretically important in influencing the outcome variable were included in a logistic regression model. All tests were performed at a significance of <math>P &lt; 0.05</math>. Competition for passengers with other public transport operators (83%), negligence of road safety rules (78%) and inadequate helmet usage (62%) were the main factors perceived to be associated with boda-boda accidents. Other factors identified by the respondents include age of the boda-boda rider (58%) and drug use (56%) (<math>P &lt; 0.05</math>). At multivariate analysis, competition for passengers (AOR 17, 95%CI 1.34-26.5) and being in between 18-25 years old (AOR 19, 95%CI 1.42-27.1) remained statistically significant. This study revealed behavioral factors by all public transporters as the main factors associated with boda-boda accidents in the Urban Kampala. This demonstrates the need for holistic interventions to address such boda-boda accidents in Uganda. Such interventions can be through digitization of transport system for clients to engage remotely with the transport operators, routine refresher trainings of all transport operators and construction of lanes for boda-boda riders.</p>
167	<p>Imberger, K. Naznin, F. Catchpole, J.</p>	Driver Risk Driver Psychology Penalty Systems	Offence and crash involvement of high frequency, high-risk offenders	<p>There is a high-frequency, high-risk offender group that is a high road safety risk and large economic burden on the Victorian community. This group continues to commit offences regularly, despite incurring demerit points, driving bans, court appearances, imprisonments, vehicle impoundments and crash involvements. Therefore, inducting this group into some form of countermeasure program could curtail their offending and risk-taking and thus reduce road trauma, and the economic cost of operating Victoria's traffic enforcement, justice and licensing administration systems. An earlier study developed a method of identifying this group of offenders, and the current study aimed to reselect a more up to date cohort and understand their characteristics during selection and follow-up periods. The current study also aimed to determine how many crashes and other events such as offences could be saved by a highly effective countermeasure program designed especially for this offender group.</p>

168	McLean, R. Butler, M. Shope, J.T. Kerse, N. Connolly, M.J.	Older Drivers & Road Users Safer Mobility Legislation and Law	Screening older drivers: the experiences of general practitioners with medical fitness to drive assessments	Highly-motorised countries have increasing numbers of ageing older drivers. In many of these jurisdictions, health practitioners are responsible for undertaking the screening of older drivers, via medical assessment of fitness to drive (FtD), to ascertain suitability to continue to hold a driver's licence. In New Zealand, all older drivers are required to have a medical FtD assessment at ages 75 years, 80 years and then biennially. This study used an interpretive description qualitative methodology to understand the FtD assessment process from the perspectives of ten general practitioners (GPs). The results indicate that GPs use FtD assessment as a way of staging a clinical conversation about mobility and driving cessation. The assessment process, however, challenges a patient-centric approach and can negatively impact relationships. This study also highlights several system issues encountered by GPs, limiting their capacity to provide best practice FtD assessments and mobility counselling for older adults.
169	Imberger, K. Watson, A.	Speed, Speeding & Travel Speeds Driver Risk Enforcement Programs Penalty Systems	Effectiveness of vehicle impoundment for Victorian high level speeders	Victoria Police have had the power to impound the vehicles of particular offenders since 2006 as part of "anti-hoon" laws. At this time impoundment lasted 48 hours (Stage 1), with three months for repeat offenders. In 2011 the impoundment laws were revised to allow 30 day (Stage 2) impoundment for a first offence. The two impoundment stages were investigated for effectiveness on speeding offending for high level speeders (who speed 45 km/h or more over the limit) as part of a wider project evaluating the effect of various sanctions on speeding drivers. The impoundment countermeasure was introduced after others, such as increased licence bans and demerit points. The results for both stages of impoundment were favourable and showed that impoundment reduced speeding re-offence rates. In addition, the impact of the licence ban was greater for those who experienced impoundment, indicating the value in both these sanctions in reducing high-level speeding.
172	Feng, Y.R. Meuleners, L.B. Ng, J.Q. Fraser, M.L. Tjia, D. Mortlet, N.	Older Drivers & Road Users	Changes in driving performance after first and second eye cataract surgery: a driving simulator study	Driving is heavily dependent on vision. Whilst self-reported driving-related difficulties reduce after cataract surgery, less is known about the impact of cataract surgery on objective driving performance measures. This study recruited patients with bilateral cataract from three public hospital ophthalmology clinics in Western Australia to investigate changes in driving performance as measured by a driving simulator. Participants completed a research-administered questionnaire, a cognitive assessment, three visual tests and a driving simulator assessment before and after first and second eye surgery. After adjusting for potential confounders, the number of crashes/near misses decreased after both first and second eye cataract surgery, whilst the amount of time speeding only reduced after second eye surgery. As binocular contrast sensitivity improved, the risk of crashes/near misses and the amount to time speeding were reduced. These findings support the importance of timely first and second eye cataract surgery for cataract patients.

174	Wescombe, A.	Road Design Intersections and Roundabouts Signage & Signalisation Crossings (Pedestrian, School, Rail, Rural/Animal)	Traffic Analysis – AI from a bird's eye view	Traditional methods of traffic data collection are primarily limited to vehicle data collection only, or requires labor intensive manual observations that can be prone to error. To provide a complete and comprehensive understating of how an intersection, the collection of aerial imagery is used to survey a traffic scene. This enables the observation of the behavior and interaction of all road users, including pedestrians and bike riders. This footage is processed using artificial intelligence, which assigns user classifications, determines interaction between users, and calculates turning movements. Further information is collected on origin destination, traffic behavior and desire lines. The data collected is analysed to determine critical safety operation, including time to collision and post encroachment time. Traffic behavior can be determined by analysing dwell time, evasive behavior and signalised intersection compliance. Understanding the fundamental interaction between road users allows practitioners to improve road spaces to align with safe system principles.
175	Biswas, R.K. Olivier, J. Senserrick, T. Williamson, A. Friswell, R.	Distraction & Inattention Driver Risk Hazard Perception	Definitions and associated factors of headway: a systematic review of passenger vehicle studies	Unsafe headway or driving too close to the lead vehicle in a moving traffic risks rear end crashes; a leading crash type in Australia. This review aimed to systematically review headway definitions and associated factors in light passenger vehicle studies published between 1980-2020. Of 5442 articles identified, 110 were retained. Only 49.6% defined headway sufficiently for reproducibility. Nine broad domains of associated factors were observed: speed, lead vehicle type, traffic condition, road characteristics, task engagement, driving under influence, weather, demographics, and safety alert system that affect headway. Improving definitions and addressing these domains is necessary to reduce rear end crashes.
177	Reynolds, A.	Emergency Hospital Trauma Other Mobility Transport - Scooters, Segways, Quad bikes and SSVs, Horses, etc.	E-Scooters – are they last mile solution or the last mile health problem?	The "Last mile Problem" describes the difficulty in getting people from a transportation hub including railway stations, bus depots and train stations to their final destination. Micro-mobility devices including two wheeled motorised devices such as e-bikes, e-scooters, e-skateboards and Segways are considered a solution to the 'last mile transport' problem and are becoming increasingly popular globally. In September 2017, e-scooter company 'Bird' launched its first scooter sharing service in Santa Monica. Since then it has grown to over 100 cities and facilitated over 10 million rides. Various other companies have launched e-scooter ride share initiatives around the globe. Findings of this review indicate that there was a sudden increase in presentations to the emergency department following the launch of shared e-scooters.

178	Mongiardini, M. Stokes, C. Leone, P. Marchesan, C. Premrl, J. Varsos, P. Grzebieta, R. Williamson, A.	Road Environment Speed, Speeding & Travel Speeds	Evaluate travel speeds and associated risk of casualty crashes through intersections in Australia using naturalistic driving data	Numerous crashes occur at intersections due to their inherent nature of creating potential points of conflict between traffic flows from different directions. To minimise the risk of casualty crashes, intersection designs should mitigate travel speeds within safe energy levels. This study aims to identify speeds and associated casualty risks of Australian drivers when travelling through some of the most common types of intersections. Speeds of vehicles travelling in free-flow fashion through 93 intersections were extracted from the dataset of the Australian Naturalistic Driving Study (ANDS). Potential correlation of average and 85th-percentile speeds with intersection design characteristics was investigated. The risk of casualty crashes was assessed based on average speed and expected impact angles for each type of intersections. Of all the types of intersections considered, roundabouts are characterised by the lowest average and 85th-percentile travel speeds, and the only design with average speeds resulting in a casualty risk below 10%.
180	Wade, S.D. Ranasinghe, N. King, T.	Speed, Speeding & Travel Speeds Road Environment Heavy Vehicles - Trucks, Buses, Hazardous Materials (ITS - vehicles) Intelligent Transport Systems in Vehicles	Road safety innovation for heavy truck movements across structures	Transurban operates managed motorways, including Melbourne's CityLink, which connects to public motorways in the north, south and west of the city. CityLink is divided into two sections, the north-south leg known as the Western Link and the east-west leg known as the Southern Link. As part of Victoria's current 'Big Build', construction resources such as heavy steel and pre-cast concrete beams are required to be transported by trucks along CityLink and other parts of the road network. The 'Big Build' is a government initiative involving numerous infrastructure projects, including the removal of a number of rail level crossings at multiple locations throughout Victoria. CityLink comprises a number of elevated road structures and, as part of accommodating these trucks, Transurban reduced the structural and operational risk for travel by developing a tool for use by heavy vehicle operators, allowing them to have visibility whilst en-route of where and how to travel.
182	Page-Smith, J. Schuster, R. Ziekemijer, P. Bishop, B.	Speed, Speeding & Travel Speeds Driver Risk	Country driver behaviour	Road deaths in regional Victoria have increased, with at least half of all Victorian road fatalities occurring in regional Victoria since the mid-2000s. Internal TAC research suggests that the majority of people killed on roads in regional Victoria are residents of regional Victoria. A large proportion of these died close to home. Survey results suggest there are few significant differences in self-reported road safety behaviours between regional and metropolitan residents; and corresponding potential outcome(s) given greater exposure on higher speed rural roads were explored. This study primarily investigates differences in road safety related attitudes and behaviours between residents of regional Victoria and their metropolitan counterparts; and is focused on 2018 results. Expanded Road Safety Monitor results from 2019 will be available at the time of presentation.

183	Doecke, S. Elsegood, M. Ponte, G.	Hazard Perception Crash Data Collection Crash Data Analysis Data Linkage	Pre-crash driver reactions from event data recorders	A considerable number of modern vehicles contain event data recorders (EDRs) that detect when a collision has occurred and log the last few seconds of driving data prior to the crash. The Centre for Automotive Safety Research's EDR study (CASR EDR) that began in 2017 has collected 335 EDR files from crashed vehicles and matched them to police reports and injury data from hospitals. EDR files from the bullet vehicles in this sample were analysed in order to gain fresh insights into pre-crash driver reactions. Only half of the drivers engaged in hard braking and/or evasive steering prior to a crash and the average speed reductions are generally lower than 14 km/h. This may have implications for the effectiveness and operation of vehicle technologies that seek to improve pre-impact braking or autonomously steer around a hazard and speed limit policies that are based on safe impact speeds.
184	Truelove, V. Oviedo-Trespalacios, O. Freeman, J. Davey, J.	Distraction & Inattention Young Drivers General Enforcement	A mixed-methods study examining the impact of legal enforcement on concealed phone use while driving	Legal countermeasures have been implemented in Australia and many jurisdictions worldwide in an attempt to reduce mobile phone distracted driving. However, an important factor that has frequently been overlooked is that legal countermeasures may counterintuitively promote the behaviour of trying to conceal the phone while driving. This study used a mixed method design, consisting of focus groups and a longitudinal survey, to examine concealed phone use while driving among young Queensland drivers. The focus groups identified that reading messages while driving was reportedly the most frequently engaged in phone use while driving behaviour and it is easy to conceal, therefore this behaviour was the focus in the longitudinal survey. The overall results revealed that the current perceived certainty of being apprehended for phone use while driving has a limited deterrence influence for concealed phone use while driving, however avoiding punishment is a strong predictor of future engagement in the behaviour.
185	Ziekemijjer, P.E. Page-Smith, J. Reynolds, A.	Driver Risk Restraints Crash Data Analysis	Injury prevention hot-topics: trauma associated with seatbelt non-use and ute occupants	An investigation into Victorian road trauma trends combined with attitudinal and behavioural data in relation to seatbelt non-use and involving ute occupants is presented. The two top selling cars in Australia are light commercial vehicles (LCV) (Heckscher, 2020) specifically utilities. 7% of Victorians report driving utes (RSM2018) with drivers of utes, almost all males, being significantly more likely to engage in dangerous behaviours than other drivers. Additionally, Victorians report high seatbelt use compliance while driving (97%) or a passenger (96%), with ute drivers less likely (91%) to always wear their seatbelts when driving.

188	Tucker, J. Watt, C. Hocking, N. Browning, T.	Advocacy Communication and Media Distraction & Inattention Education – general and other	Set your phone then leave it alone – an anti-distraction campaign	Driver distraction from interacting with mobile phones is an ongoing issue in Queensland, across Australia and internationally. The Royal Automobile Club of Queensland (RACQ) partnered with the Motor Accident Insurance Commission (MAIC) to develop a campaign aimed at reducing drivers' interactions with mobile phones through education, encouraging a fresh approach through explaining how to set their phones to 'do not disturb' (DND) mode prior to driving. The campaign comprised social and traditional media and included activation events, out of home, cinema, radio, online and television advertisements. Longitudinal market research was conducted in July 2019 (establishing pre-campaign baseline), in August 2019 (following wave 1 of the campaign), and in January 2020 (following wave 2 of the campaign). At the end of the campaign, significant changes were evident – including a significant reduction in hand-held phone use whilst driving and an increase in use of the DND phone function.
190	Minogue, K.	Policy Development And Implementation Insurance Legislation and Law	When the rubber hits the road - Australia's motor accident injury insurance schemes and autonomous vehicles	With human factors consistently playing a role in motor vehicle accidents, autonomous vehicle technology is expected to dramatically improve road safety. But significant challenges arise in ensuring that, under motor accident injury insurance (MAII) schemes across Australia, coverage is uniform whether a person is injured or killed in an automated vehicle crash or in an accident involving a human driver. MAII schemes differ in the ways they provide compulsory personal injury insurance cover for crashes and a consistent national approach to injury insurance is imperative. Significant reform work is underway with the National Transport Commission (NTC) specifically targeting the area of motor accident injury insurance (MAII) in their 2019 policy paper. This talk will report on the reform work being done as well as canvassing the ongoing challenges of insurance coverage in accidents caused by automated vehicles.
192	Waller, E. Woolley, J.	Policy Development And Implementation Road Safety Strategy Safer Mobility Safer Transport & Mobility	Safe system capability development in the context of industry	The safe system approach underpins Transurban's road safety strategic framework. To support our capability in road safety, Transurban has implemented regionally based road safety action plans that reflect the safe system pillars. We have also established a road safety community of practice with members drawn from across business functions and, most recently, developed a bespoke safe system professional development program. This presentation will cover the motivation for the program, its development approach, implementation and outcomes.

194	Rakotonirainy, A. Glaser, S. Bond, A.	(ITS - vehicles) Intelligent Transport Systems in Vehicles Autonomous Vehicles	Demystifying the automated vehicle trolley problem	Future Automated Vehicle (AV) capabilities, cavalierly and irresponsibly informed by Sci-Fi movies or social media, are confusing the public. The media abounds with AV scaremongers portraying future AV as a God-like entity able to decide the life and death of road users. The trolley problem is a theoretical experiment in utilitarianism and deontological ethics. It is often quoted as the ultimate moral quandary that AV will solve despite human unable to reach a consensus about it. This paper highlights the methodological misconception of the AV trolley problem. We argue that the ethical trolley problem should be analysed through the lens of AV technology advances. We show that AV technology is far from being able to solve the trolley problem and are not even aiming for. This paper demystifies the perception that AV could be an intelligent weapon. It contributes to improve AV community acceptance.
195	Vanselow, J. Vagedes, X. Young, D.	(ITS - vehicles) Intelligent Transport Systems in Vehicles Autonomous Vehicles	Department of transport and Bosch CAV highway pilot trial on Victorian rural roads	As part of Victoria's Towards Zero 2016-2020 Road Safety Strategy, the Department of Transport (DoT), the Transport Accident Commission (TAC) and Bosch partnered together to develop and trial automated vehicle technology. The prototype SAE L3 Automated Driving System (ADS) was developed by Bosch, integrated in a donor vehicle, and specifically adapted to operate on Victorian high-speed rural and regional roads, where a disproportionate amount of road trauma occurs. This innovation project aims to contribute towards the long-term reduction of road trauma in this unique environment. The trial identifies key focus areas for road safety practitioners and road managers, assisting them in enabling Automated Driving (AD) on Victorian regional roads to reduce road trauma. Challenges and enablers influencing the ability of an ADS to perceive and navigate the unique Victorian rural and regional road environment were identified throughout the trial. Key points in ensuring a higher AD functional availability include the consistent application of road standards, availability of up-to-date road network data and ongoing road maintenance.
196	Harris, B. Soo, J. McKechnie, D. Filipovic, M. Young, D.	(ITS - roads) Intelligent Transport Systems in Road Infrastructure (ITS - vehicles) Intelligent Transport Systems in Vehicles	Exploring the safety potential of cellular-V2X based vehicle connectivity, results from the advanced connected vehicles Victoria trial	The Advanced Connected Vehicles Victoria (ACV2) trial is a partnership between the Department of Transport Victoria, Telstra, Lexus Australia and the Transport Accident Commission. This trial developed and tested a connected vehicle system using Cellular Vehicle-to-Everything (Cellular-V2X) technology to enable communication between vehicles and with a network hosted platform to improve safety. The ACV2 system enables safety warning messages to be delivered to vehicles with very low latency using the existing Telstra 4G network. This approach to connectivity gives the potential for wide-scale deployment without significant roadside infrastructure expenditure, which will be a large hurdle for adoption. It is anticipated that this technology solution could facilitate earlier realisation of vehicle connectivity and its potential safety benefits. The trial successfully tested six road safety-oriented use cases that consider speed, intersections, Vulnerable Road Users (VRU) and rear-end crashes. The key lessons learnt and implications for future road safety applications will be shared.

197	Somers, A. Johnston, D. Vanselow, J.	Intersections and Roundabouts (ITS - roads) Intelligent Transport Systems in Road Infrastructure Autonomous Vehicles (ITS - vehicles) Intelligent Transport Systems in Vehicles	Adapting automated vehicle perception for safer roads, results from the omni-aware trial project	An innovation project was funded through the Victorian Government's Towards Zero Action Plan to equip a crash hot-spot intersection as part of the Connected and Automated Vehicles Trial Program. This is understood to be the first long-term deployment of this type within the Asia Pacific region and one of very few around the world. This paper introduces the Omni-Aware technology used in the trial project and will report on the results and lessons learned. Omni-Aware draws upon Automated Vehicle sensing technology by deploying multiple LIDAR (Light Detection and Ranging) sensors to an intersection to build a highly accurate continuous spatial awareness of all pedestrians, cyclists, cars, buses and trucks.
198	Poulter, C. Muir, C. Wishart, S. O'Hern, S. Stephan, K. Newstead, S. Newnam, S. Vu, L.H.	Driver Risk Hazard Perception Legislation and Law Workplace and Work Related Road Safety	Investigating driver compliance with road rule 79A in Victoria	The purpose of this project was to investigate driver compliance with Road Rule 79A (RR79A), which requires drivers to slow to 40km/h when passing a stationary enforcement/emergency vehicle. To investigate driver compliance with RR79A, a study was conducted involving a community survey, an on-road driver compliance study involving retrospective analysis of CCTV footage on a high-speed road and focus groups with emergency service workers. Awareness of the rule was high among community survey respondents, however their understanding of the circumstances in which the rule applies was far lower. Observed compliance was low, with less than 40% compliance across all emergency vehicles in the on-road study. Close following distance, non-compliance of other drivers, and limited visibility of enforcement and emergency vehicles were identified as major barriers to compliance.
200	Graham, P.	Driver Risk Motorcyclists	Motorcycling – high risk, but legitimate form of transport	Motorcyclists still make up around 18% of all road deaths and serious injuries in New Zealand, despite representing less than 3% of road users, and make up a disproportionate share of ongoing health cost and trauma. In order to address motorcyclists themselves, a detailed analysis of recent crash data was undertaken, along with qualitative research among motorcycle riders, to understand the factors which might lead to a useful conversation with this target audience, by treating them as legitimate road users in a safe system.
201	Moon, W. Corben, B. Ultmann, Z. Strandroth, J. Riess, A.	Policy Development And Implementation Road Safety Strategy Road Safety in a Global Perspective Workplace and Work Related Road Safety	A modernised safe system model	While the safe system model has been active in Australasia for over a decade, jurisdictions have implemented it to varying degrees and with varying success. This model takes a holistic view of the road transport system and the interaction of various elements including roads and roadsides, travel speeds, vehicles, and road users. It aspires to create a road transport system where human mistakes do not result in death and serious injury. Traditionally, these four pillars have been represented as a circle with four quadrants with no clear explanation as to how each of these quadrants interacts with each other and functions within the system. This paper discusses how the integration of the pillars can improve the implementation of road safety measures and the development of genuine 'system design'. This system design approach could enhance current geometric design guides and enable the elimination of harm over a set time frame.

202	Mortimer, M. Wrzesinski, C. Chapman, S. Horan, B.	Novice Driver/Rider Licensing Education – general and other	Using virtual reality to increase awareness on safe interactions between light and heavy vehicles	The first year of independent driving is associated with high crash and fatality rates. While there are a number of initiatives focusing on improving safety for younger drivers there remains little focus on safe interactions between light and heavy vehicles on our roads. This paper discusses the use of Virtual Reality (VR) to facilitate two different VR experiences involving interactions between light and heavy vehicles from a perspective that most drivers wouldn't typically experience. The first experience focuses on a heavy vehicle's safe braking distance and the second on the need for heavy vehicles to use two lanes when making tight turns. For each situation the participant experienced the same interaction as both a passenger in the light and heavy vehicles. Results show that participants were able to empathise with each of the drivers and gain increased awareness around safely interacting with heavy vehicles.
203	Daley, M. Elhenawy, M. Masoud, M. Glaser, S. Rakotonirainya, A.	Crash Avoidance and Crash Severity Reduction (ITS - vehicles) Intelligent Transport Systems in Vehicles Bicyclists Pedestrians	Detecting road user mode of transportation using deep learning to enhance VRU safety in the C-ITS environment	This research aims to achieve the highest level of injury prevention by developing a deep learning approach to enhance Vulnerable Road Users (VRU) safety in the Cooperative Intelligent Transport Systems (C-ITS) environment. The proposed approach provides strong classification capabilities for transportation mode detection based on using the total linear acceleration data across 1-second monitoring for each reachable C-ITS entity inside the communication coverage. The results on the validation set showed a binary classification accuracy of 93.04% when distinguishing between VRU (individuals Walking, Running, or Cycling), and Non-VRU (individuals in a Car or Bus). This accuracy decreases to 88.64% and 80.50%, based on four and five classes metric consecutively that can stratify VRU modality and demonstrates the difficulty of accurately distinguishing transportation by car and bus. The approach warrants further testing and may hold promise for future C-ITS development and efficient implementation.
204	Vanselow, J. Harris, B. Soo, J. Young, D.	Autonomous Vehicles (ITS - vehicles) Intelligent Transport Systems in Vehicles Policy Development And Implementation	Towards zero connected and automated vehicle trial grants program –identifying road safety actions through public-private collaboration	To achieve its longer-term vision of zero lives lost on Victorian roads, the Victorian Government's Towards Zero road safety strategy recognised the need to investigate future technologies' potential contribution to delivering this vision. To this end the Victorian Government allocated \$9 million to facilitate a trial of Connected and/or Automated Vehicle (CAV) technology on Victorian roads. The trials aimed to inform and support Victoria's readiness for these technologies in order to realise their potential safety benefits. The CAV trial grant projects will be evaluated against the program's original purpose, and the value of the projects to the Victorian government will be assessed. The projects required industry and government collaboration to achieve the project goals. Partnership between government and private industry presents opportunities and challenges for both parties but fundamentally, closer ties allow for better understanding for addressing problems and generating solutions for public benefit.

207	Chan, M.	Heavy Vehicles - Trucks, Buses, Hazardous Materials	Developing a heavy vehicles safety features roadmap in order to promote safer heavy vehicles beyond the basic legal requirements	Victoria Government has a large pipeline of significant infrastructure projects being delivered over the next 10 years. Amongst these projects are high value multi-year investments including Metro Tunnel, West Gate Tunnel, Railway Crossing Removals and North East Link. The majority of these infrastructure projects are being undertaken in the Melbourne central business district (CBD), highly populated inner suburbs on the fringe of the CBD, and metropolitan areas. Heavy vehicles are interacting constantly throughout the day with vulnerable road users on their way to and from the numerous project sites and its surrounding areas. The purpose of this heavy vehicle safety features roadmap is to promote safety beyond basic legal requirements.
209	Graham, P.	Road Safety Strategy Crash Data Analysis	Estimating the effect of multiple combined interventions: the IILM	The Integrated Intervention Logic Model (IILM) is a tool developed by the New Zealand Transport Agency (NZTA) in partnership with key road safety stakeholders to inform strategies aimed at improving safety across the network. The tool uses crash data and evidence-based research and models to estimate reductions in deaths and serious injuries (DSIs) based on a specific dose of each intervention working in synergy. It includes a baseline projection of deaths and serious injuries against which the impacts of the interventions can be estimated. Twelve interventions have been modelled to date.
210	Vanselow, J. Somers, A. Johnson, D. Young, D.	Intersections and Roundabouts Road Safety Audit and Road Safety Review (ITS - roads) Intelligent Transport Systems in Road Infrastructure Crash Data Collection	Using lidar data for analyzing road safety at an intersection – evaluation of the Omni-Aware data-set for road safety research	The Victorian Government has partnered with Omni-Aware to conduct a trial of technology to help improve road safety at intersections. Light Detecting and Ranging (LIDAR) sensors are often used by Connected and Automated Vehicles (CAVs) to perceive and navigate the road environment, however the Omni-Aware project takes LIDAR technology to the roadside to test its potential to bring the benefits to more road users sooner. One intersection in Melbourne was equipped with LIDAR sensors at each corner, the point clouds were merged to produce a single dataset that can be used to identify road user movements through the intersection. The result is a rich dataset with huge potential for road safety research. This paper will describe the dataset including any limitations and assumptions. Road safety researchers can access this data by application to the Department of Transport.
211 (Poster)	McIntyre, J. Neumayer, H.	Crossings (Pedestrian, School, Rail, Rural/Animal) Bicyclists Pedestrians School Safety	Darebin's octopus school pilot program	The Octopus School program is a Darebin City Council initiative designed to increase the number of students actively travelling to school, along with decreasing congestion and improving road safety in primary school precincts. Council has been working directly with schools and the local community to manage travel to school issues for over ten years, including investment in school infrastructure through Walking, Cycling, Speed reduction, and Traffic Management capital programs, and externally supported programs such as Bike Ed, Walk to School and Fit 2 Drive. Council developed an approach to work intensively with one school every year to complete four modules, which represent varying amounts on engagement from different stakeholders, culminating in the construction of road safety treatments funded by Darebin Council. The four modules assist the school with setting up a sustainable program of achievements to embed active travel behaviours across the community.

213	Baththana, J. Zia, H.	Road Safety Strategy Community Programs Road Safety Programs	Using community feedback to complement road safety risk metrics	In 2019 New Plymouth District Council (NPDC) completed district-wide consultation to gather feedback on road safety issues in the district under the assumption that locals know local roads best. Consequently, the New Plymouth district wide safety review tool was developed to explore the opportunity to use community feedback to complement commonly used road safety risk metrics. Typically, metrics such as Collective Risk and Personal Risk and more recently Infrastructure Risk Rating (IRR) have been used to prioritise road safety improvement projects in New Zealand. This new tool will enable practitioners the use of community ideas and concerns in prioritising road safety projects, ensuring an inclusive decision-making approach.
214	King, M.J. Rodriguez, J.E. Oviedo-Trespalacios, O.	Pedestrians Safer Mobility Statistical, Epidemiology and Other Road Safety Research Methods Emergency Hospital Trauma	Injury while drink walking in public places: comparison of patterns associated with vehicle collisions and falls	Drink walkers are at high risk of collision with vehicles, however they are also at risk of falls when using footpaths and related public places, an issue of greater relevance in the current context of promotion of active travel alongside the move Towards Zero. Differences in drink walking and injury patterns were investigated using 10 years (2008-17) of Queensland Injury Surveillance Unit data. Preliminary results show that pedestrian falls are six times more common than vehicle collisions, while drink walking comprises a larger percentage of falls cases (9.0%) than collisions with cars (5.5%) or motorcycles (5.9%). In contrast, males are more highly represented as drink walkers in collisions with cars (82.5%) than falls (63.3%). Together with age differences, the results point to a need to focus on pedestrian infrastructure on footpaths and related areas to reduce falls risk, and exploration of the contribution of differences in spatial and temporal exposure.
215	Talukdar, M.M.A. Raihan, M.A.	Speed, Speeding & Travel Speeds	Over speeding and road safety in Bangladesh	Over speeding is one of the major causes of road traffic crashes in Bangladesh. Heavy vehicle drivers violate the speed limits frequently even at the crash prone locations of the highways. The main objective of this study was to investigate the potential causes of over speeding that triggers the crash probabilities. Questionnaire surveys followed by an in-depth interview were conducted at different heavy vehicle bus and truck terminals of Dhaka city from July to December 2018. While researching the reasons behind over speeding, it was found that saving time (37%), and carrying more passengers and quick delivery of goods (14%) were the triggering factors. Other significant factors were driving at free flow speed (17%) whenever possible, escaping from police harassment (10%), earn more thus making more trips (13%), and overcoming the time lag from congestion (9%). A combined public-private initiative is thus essential to address the over speeding related crashes on the highways in Bangladesh.

216	Samadder, M Mondal, T.N.	Community Programs Road Safety Programs	Examining group dynamics: involving community people towards safer road	Road accident is considered as one of the leading causes of death in recent years. In Bangladesh, roads are nothing but killing machines which ranked it first among the South Asians countries. Besides all the initiatives taken organizing small groups at the community level to reduce road accidents across rural areas in Bangladesh is a pressing priority. Several NGOs undertook different initiatives in achieving road safety and reducing fatalities in roads. Following Tuckman's model, this paper analyzes the relevance of group dynamics and the effectiveness of CRSG (Community Road Safety Group) as a model for ensuring road safety based on six different groups which were intensively studied in different stages of qualitative research method. Due to lack of group coordination actions taken for reducing road fatalities was less effective. Recognizing the group's effort in attaining road safety, incessant interrelations, inspirations, and supervisions can only sustain it's success and functions.
217	Davis, C.I.	Speed, Speeding & Travel Speeds Road Environment Road Design IRAP, AusRAP, etc.	Impact of community reaction on Mildura Council's speed reduction project in residential streets	Aiming to improve community safety and livability, in 2015 Mildura Rural City Council (MRCC) embarked on a review of speed related safety on 1,000km of its sealed road network. This paper analyses the impact of community reaction while providing an overview of the project. The review included collection of AusRap and ANRAM data, commissioning a review of all project area speed limits, to make new speed reduction recommendations, and validate through community consultation acceptance of the proposed recommendations. Broadly, the review recommended 40 km/h in all residential streets. Three randomly selected focus groups unanimously supported the recommendations. However, during construction there were unexpected negative print and social media attacks on council and its staff, predominantly focused on construction of the island thresholds, and not on the reduced speed limits. The consultation learnings explored in this paper could assist practitioners to plan community consultation in their speed reduction programs.
218	Messias, D.	NCAP And Consumer Test Ratings Communication and Media Crash Data Analysis Statistical, Epidemiology and Other Road Safety Research Methods	Developing a marketing strategy to increase Victorians' vehicle safety awareness and influence purchase decisions towards safer vehicles	Vehicle safety technology has seen a dramatic advancement in the past decade. However, not all models available to consumers offer the same level of safety content. Vehicle buyers tend to take safety for granted and are generally unaware of the latest technologies. Safety is usually a low-ranking factor in purchasing decisions. This paper discusses findings from a study commissioned by the Victorian Department of Transport to address current gaps in vehicle safety awareness. The research combined the power of behaviour research, data analytics and strategic marketing techniques to develop the new Victorian Government's marketing and communication strategy for vehicle safety through an evidence-based approach. Findings from the research are used to deliver targeted, compelling and cost-efficient messages to increase vehicle safety awareness and influence consumers to prioritise safety in their purchase decisions.

220	Brain, D.	Heavy Vehicles - Trucks, Buses, Hazardous Materials Workplace and Work Related Road Safety	Consignors of import containers play a critical role in preventing heavy vehicle rollover, but they're often unaware of their role.	Significant on-road incidents involving container-laden heavy vehicles are 36% more likely to result in rollover, compared to vehicles carrying general freight (NTI, 2018). A common causal factor in these incidents is load shift within the container, causing the vehicle to become unstable and roll while navigating bends or turns. Loads inside containers shift due to inadequate packing and restraint. Incident data suggests that container packing is not being sufficiently prioritised by the supply chain, and container-laden heavy vehicle rollovers continue to occur due to packing deficiencies. While the issue exists across all container movements in Australia, import containers tend to be highly represented in the data. The volume of container imports to Australia is forecast to double by 2029 (BITRE, 2019. BITRE, 2014). With >80% of container trips to/from Australian ports completed by trucks (BITRE, 2019), addressing container packing deficiencies in import containers is an essential step towards zero.
221	Sharwood, L.N. Logan, D. Scott-Parker, B.	Road Safety Programs Crash Data Collection Data Linkage Statistical, Epidemiology and Other Road Safety Research Methods	Can I have your attention please? Piloting an outcome evaluation on pre-novice driving youth aiming to determine the 'bstreetsmart' impact.	Road deaths and serious injuries among young novice drivers remain unacceptably high. They are among the most vulnerable road users in Australia; drivers 16-19 years are 6-8 times more likely to crash than those 55-59 years. Crash/injury prevention action must be multi-pronged to address the multiple factors influencing novice driver behavior and their willingness to engage in risky driver behavior. Bstreetsmart is a road-safety program targeting around 25,000 pre-driving youth across NSW annually. Despite increasing attendance, no formal outcome evaluation has previously determined the programs impact on pre and post knowledge and attitudinal changes. Engagement with this age demographic is historically challenging. Using pre-post survey methods, a smart-phone based app, teacher engagement, participation incentives, we surveyed 2630, 1000 and 178 students' pre, post and 3 months post-event respectively. Despite poor response fractions, attitudinal change was significant immediately post, with some sustained at 3 months. Full results will be presented.
222	Wagdy, A. Elhenawy, M. Masoud, M.	(ITS - roads) Intelligent Transport Systems in Road Infrastructure Road Design Road Environment	Glare safety problem in tunnels and underpasses in Australia	High Luminance variations experienced when entering and exiting underpasses may cause severe crashes due to the occurrence of glare and the black-out effect. In this study, we propose a methodology using dynamic solar reflectors to minimise the high light variations that arise over a short distance at the underpass endpoints. First, a field investigation was conducted in one underpass in Brisbane, Australia to capture High Dynamic Range Images from the Field Of View of drivers to analyse their visual experience. Then, Radiance simulation engine was used for advanced conducting advanced glare analysis on the underpass 3D model, and Grasshopper was used for parametric modelling of the dynamic solar reflectors which aimed to reduce the luminance contrast. These reflectors were optimised to smooth the sharp transition between the maximum and minimum luminance experienced at these locations. Results showed the effectiveness of the proposed method in reducing the contrast level.

223	Albanese, B. Bohman, K. Bilston, L. Cross, S. Koppel, S. Charlton, J. Olivier, J. Keay, L. Brown, J.	Child Restraints	Can specific child restraint design features improve correct use?	Ergonomic and user-friendly design features are thought to facilitate correct use of child restraints. Despite attempts at intervention, incorrect use of child restraints is widespread, and the optimal design of a child restraint to minimise incorrect use remains unknown. This body of work, comprising of three studies, aims to investigate whether targeted child restraint design can increase correct child restraint use. Incorrect use arising from errors introduced by both the child and parent/carer was investigated using naturalistic and laboratory studies. These data show that differences in child posture, belt positioning, comfort and error rates exist between restraints of varying design. To date, one specific design feature was found to be effective in reducing adult user errors during installation tasks involving the vehicle's seat belt. Together these preliminary results suggest restraint design changes have considerable potential to increase the correct use of child restraints.
224	Tyler, W.J.P. Stokes, C. Woolley, J.	Road Design Crash Data Analysis Statistical, Epidemiology and Other Road Safety Research Methods	Using in-depth accident data to identify limitations when applying crash injury risk curves	Injury risk curves outline the relationship between speed and the risk of high severity outcomes for certain crash configurations, and hence are a convenient tool for road infrastructure design practitioners when assessing the safety of certain road designs. However, aggregation of data used to create these risk curves can hide important complexities that limit their usefulness. The aim of this study is to contextualise such risk curves with respect to other determining factors of crash injury severity. In-depth crash investigation data from the Initiative for the Global Harmonisation of Accident Data (IGLAD) database is used to compare the predicted risk of high severity outcomes with actual severity outcomes of crashes. The results of this study suggest that the risk of high severity outcomes was either under- or over-predicted for a substantial proportion of crashes within the database.
225	Pinnow, J. Elhenawy, M. Masoud, M. Larue, G. Glaser, S. Rakotonirainy, A.	Crash Avoidance and Crash Severity Reduction Crash Data Analysis Crash Data Collection Crash Testing	Crashes classification in naturalistic driving scenarios using random forest machine learning algorithm	This research analyses the viability of utilising observed kinematics in machine learning models to identify safety critical events (SCE's). There is a need for efficient algorithms to identify SCE's in large datasets, such as naturalistic driving studies (NDS). Typical threshold approaches, while fast, often fail to distinguish between normal driving and SCE's. The methodology proposed presents strong evidence that kinematic features used in machine learning models have good classification capabilities. Three approaches were used to analyse 100-car NDS observations: trigger threshold approach (TTA) and two machine learning methods, single point random forest model (SPRFM) and time-shift random forest model (TSRFM). The TSRFM model performed the best, followed by SPRFM and TTA respectively. The results showed that these machine learning methods can better classify crashes and non-crashes than conventional trigger threshold approaches.

227	Kong, S. Gnim, C. Him, Y.	Early Childhood Road Safety Pedestrians Speed, Speeding & Travel Speeds Statistical, Epidemiology and Other Road Safety Research Methods	Enhancing road safety knowledge and practice around rural school zone in Cambodia	Cambodia has seen a rapid increase of almost 500% in its road traffic over the last 10 years with 88% of those newly registered vehicles being motorcycles. Together, limited enforcement and improvement of the safer road engineering has led to increasing speeds resulting in more frequent serious crashes along both the national and local community road networks. Farmers, workers and students continued to be the high-risk groups of road traffic crashes contributing to 76% of total road crash fatalities in 2018. Speeding was the main cause of road crash fatalities (38%), and 68% of those were motorcyclists <sup>1</sup> . On average, at least 5 people died and 11 more were seriously injured on Cambodia's roads everyday, creating enormous impact on the social and economic welfare of the country with an estimated annual cost 400 million US\$, representing about 2% of the country Gross Domestic Product (GDP) <sup>2</sup> . Adopting the national road safety action plan that aligned with the UN Decade of Action for Road Safety 2011 – 2020, road crash fatality was forecasting to halve by 50% aimed at saving 7,350 lives <sup>3</sup> . This study examines practices, measures and approaches implemented via global, regional and country sustainable best practice. Observation and assessment on community challenges, experience, socio-economy, culture, understanding, belief, commitment and cooperation among school teachers, parents, student councils and local authorities together with civil societies, private sectors and donor organisations over time were explored in this study.
226	Jurewicz, C. Hall, C.	Road Design Intersections and Roundabouts	Safe system infrastructure innovation in Victoria's safer roads program	Safe System infrastructure development progressed significantly during the past five years. Most of this development has been delivered through practitioner-led innovation. This abstract describes progress on several Safe System infrastructure innovations undertaken by Safer Roads program funded by Transport Accident Commission (TAC). These innovations include trials of signalised intersection platforms, rural side road activated intersection speed limits, compact roundabouts, and cushioned pedestrian crossings. Future innovation potential of additional designs is also discussed. The presentation will showcase how TAC-funded infrastructure innovation is expanding Safe System implementation and practitioner design choices.

227	Kong, S. Gnim, C. Him, Y.	Early Childhood Road Safety Pedestrians Speed, Speeding & Travel Speeds Statistical, Epidemiology and Other Road Safety Research Methods	Enhancing road safety knowledge and practice around rural school zone in Cambodia	Cambodia has seen a rapid increase of almost 500% in its road traffic over the last 10 years with 88% of those newly registered vehicles being motorcycles. Together, limited enforcement and improvement of the safer road engineering has led to increasing speeds resulting in more frequent serious crashes along both the national and local community road networks. Farmers, workers and students continued to be the high-risk groups of road traffic crashes contributing to 76% of total road crash fatalities in 2018. Speeding was the main cause of road crash fatalities (38%), and 68% of those were motorcyclists <sup>1</sup> . On average, at least 5 people died and 11 more were seriously injured on Cambodia's roads everyday, creating enormous impact on the social and economic welfare of the country with an estimated annual cost 400 million US\$, representing about 2% of the country Gross Domestic Product (GDP) <sup>2</sup> . Adopting the national road safety action plan that aligned with the UN Decade of Action for Road Safety 2011 – 2020, road crash fatality was forecasting to halve by 50% aimed at saving 7,350 lives <sup>3</sup> . This study examines practices, measures and approaches implemented via global, regional and country sustainable best practice. Observation and assessment on community challenges, experience, socio-economy, culture, understanding, belief, commitment and cooperation among school teachers, parents, student councils and local authorities together with civil societies, private sectors and donor organisations over time were explored in this study.
231	Sutton, H. Keulen, M. Stitt, P. Le, J. Eveleigh, M. Elsley, C. Hodges, C.	Road Environment Road Safety Barriers Road Design	The Mitchell highway safer asset cross-section pilot project	In New South Wales (NSW) just over one-third of fatal and serious injury lane departure crashes between 2014 and 2018 occurred on state highways despite state highways comprising only 9.2% of all roads in NSW. Through decades of 'black-spot' style treatment programs in NSW, many of the specific road deficiencies on state highways have been addressed. Transport for NSW (TfNSW) is now addressing the remaining systemic risks that present over entire routes. Aspirational cross-sections for different road classes with supplementary guidance on selection of safer asset cross-sections have been developed and piloted on a section of The Mitchell Highway.
233	Le, J. Eveleigh, M. Tang, J. Grima, J. Rodgers, M. Mortimer, A. Kocoski, N.	Crossings (Pedestrian, School, Rail, Rural/Animal) Intersections and Roundabouts Pedestrians Road Environment	Development and Delivery of the Pedestrian Protection at Signalised Intersection Mass Action Program	The New South Wales (NSW) Centre for Road Safety (CRS) conducted a review of pedestrian safety at signalised two-phase intersections, and the impact on safety where parallel green signal for both vehicle and pedestrians traffic signal phasing is used. Specifically, the review looked at the potential introduction of Timed Pedestrian Protection (TPP) at signalised intersections to provide temporal separation of pedestrians and vehicles. The review found that TPPs had reduced the number of pedestrian crashes at intersections. Additionally, a crash reduction factor calculation based on NSW roads estimated that if TPPs were implemented on NSW roads they could reduce pedestrian crashes at signalised intersections by up to 35%. Thus, the literature review and crash reduction factor calculation suggested that replacing parallel green signal for both vehicle and pedestrians traffic signal phasing with TPPs would significantly contribute towards reducing pedestrian crashes at signalised intersection crossings.

234	Gray, P. Macatuggal, J., Torpy, D.	Bicyclists Road Safety Programs	Identifying cycling stress to inform cycling infrastructure investment	The Victorian Cycling Strategy (the 'Strategy') has a goal of 'Investing in a safer, lower-stress, better-connected network'. To achieve this, we need to be able to clearly identify locations of greatest risk of danger for cyclists, now and into the future. The Strategy requires that a level-of-traffic stress (LTS) approach is used when investing in the cycle network. The State Government lacked an evidence-based tool for targeting and prioritising investment in the cycling network. A comprehensive LTS tool has been developed that assesses on road mid-block and intersection conditions, including infrastructure, motor vehicle speeds and volumes. Further development of the tool includes user perception testing to understand LTS from a user's perspective and use this information to refine the tool.
235	Morris, S. Maliki, R.	Intersections and Roundabouts Signage & Signalisation	Raised intersections at traffic signals in Victoria	Across Victoria, 28% of deaths and 41% of serious injuries occur at intersections. In Metropolitan Melbourne, 38% of serious casualties at intersections occur at traffic signals. To address this issue the Victorian Government invested in a trial project to retrofit raised intersections at traffic signals. Raised intersections are a speed management treatment capable of reducing the operating speeds for vehicles through an intersection to Safe System collision speeds. In 2019 seven raised intersections were installed at intersections along two routes in the Thomastown area, north of Melbourne. Following installation an evaluation was undertaken which showed the changes in mean speed on the main roads, on approach to has decreased by approximately 10.7km/h. Through the development and delivery process learnings were gathered on several aspects of the treatment such as drainage, delineation, communication strategy and truck stability, and included in the update to the Road Design Note 3.07 Raised Safety Platforms.
236	Morris, S.	Road Safety Strategy	Safer roads program staged development process	The Victorian Governments Towards Zero Action Plan, released in 2016, focuses on safe system treatments including continuous barrier projects on the Victoria's Top 20 highest risk roads. The programs lead to the Safer Roads team to revise the development process to allow the large, complex projects to be delivered within the four year Plan. The previous process relied on project submissions twice a year based on comprehensive guidelines. These guidelines would take time to develop, and never cover all potential projects. This resulted in many projects being revised, wasting time and resources. The Safer Roads team developed a ten stage process, which takes projects from an initial feasibility stage to project completion. Development under this new process concentrates on a collaborative approach between project developers and funders. It has resulted in more confidence in the projects developed and has been adopted on all Safer Roads programs.

237	Zaouk, A. Strassburger, R. Fournier, R. Willis, M.	Drink Driving (ITS - vehicles) Intelligent Transport Systems in Vehicles	Driver alcohol detection system for safety (DADSS) program and technology overview	Drink driving is a factor in approximately 18 percent of all road fatalities across Australia (Drummer et al., 2018). VicHealth estimates the social cost relating to alcohol abuse in Victoria to be \$4.3 billion, with road trauma accounting for 25.5% of this cost (VicHealth, 2020). To help eliminate alcohol-related road trauma and achieve zero deaths and serious injuries on Australian roads, the Transport Accident Commission (TAC) is evaluating a new and innovative vehicle technology; the Automotive Coalition for Traffic Safety's (ACTS) Driver Alcohol Detection System for Safety (DADSS) Passive Alcohol Sensor (PAS). The TAC will lead a trial of the PAS technology in Australia, complementing a suite of intelligent vehicle technologies (IVT) aimed at achieving Towards Zero. The DADSS PAS technology is a non-invasive method of measuring a driver's naturally exhaled breath alcohol concentration emitted into the air in the vehicle cabin. The PAS trial aim is to generate knowledge and technology planning to reduce road trauma associated with drink driving.
238	Rechnitzer, G. Grzebieta, R. Gaffney, T. Bugeja, L. Crozier, J.	Restraints Child Restraints Crash Data Collection	The "unseen passenger": current vehicle restraint systems are not designed for safety of pregnant women and their fetus	Pregnant women and their fetus are vulnerable road users who are not well protected in crashes. Current vehicle occupant protection systems (seatbelts, airbags) are not designed for pregnant women or their unborn child. While pregnant women are advised to wear seatbelts at all times, there is a serious risk to themselves and/or the fetus via placental abruption due to the lap-belt passing over the fetus and directly loading the foetal area in a crash, even in moderate crashes. Some insight is provided into this important neglected area of road safety and proposes action to help develop vehicle restraint safety systems for pregnant women and her fetus, the "unseen passenger".
243	Ranjbar, M. Hamelmann, C. Mooren, L. Shuey, R. Zakeri, H. Hedayati, J. Mehryari, F. Abdous, H. Mozafari, M. Hosseinzadeh, S.A. Hadadi, M. Shafieian, M.M.	Speed, Speeding & Travel Speeds Road Safety in Developing Countries General Enforcement Enforcement Programs	Demonstrating enhanced safety model corridors in Iran	In Iran, road traffic crashes are one of the five leading causes of fatalities. Unfortunately, in 2017, the downward trend in road fatalities had changed, after nearly a decade of decreases in fatalities. To reverse this trend, a project has been designed to demonstrate enhanced Safety Model Corridors based on the Safe System Approach (SSA) and Result-Based Management Approach (RBMA). The focus of this project is road safety engineering and speed limit reductions, strengthening surveillance, monitoring and evaluation, improved crash investigation, improved governance, enhanced law enforcement, social marketing, and quality improvement of post-crash care services. The scope and challenges of the project, planned actions and early achievements are discussed in this paper.

244	Pugsley, L. Khieu, P.	Early Childhood Road Safety Novice Driver/Rider Licensing Road User Training – General (Bicyclists, Workplace, OHS, Etc.) Education – general and other	An omnichannel approach: Queensland's road safety education blueprint for children and youth	Road trauma is a leading cause of death of Queensland children (QFCC, 2019). A whole-of-life approach to road safety education is required to shape and influence behavior which will drive a generational shift in the awareness of being a safer road user. The Queensland Department of Transport and Main Roads (TMR) recognizes the key role they play in road safety education and created a new Road Safety Education Blueprint for Queensland Children and Youth (the Blueprint). This Blueprint was developed through a review of literature, other jurisdictional initiatives, and in consultation with stakeholders across Queensland. This process identified pragmatic outcomes by analysing children's risk profiles and the current road safety education landscape including service providers, effective pedagogies and gaps across ages, content and geography. The result is a Blueprint articulating a vision for a continuum of evidence-based education across childhood through an omnichannel approach, supporting and enabling a behavioral shift of the current and emerging generation of safer road users.
245	Mooren, L. Shuey, R. Ranjbar, M. Mehryari, F. Shafieian, M. Hadadi, M. Hamelmann, C. Hedayati, J. Haddadi, M.	Policy Development And Implementation Road Safety Strategy Road Safety in Developing Countries	Speed management in Iran	The level of road trauma is high in the Eastern Mediterranean Region with the Islamic Republic of Iran having a particularly high rate. The Government, assisted by the World Health Organisation (WHO), has recently committed to carrying out some demonstration projects in three provinces that, if successful will form the basis of road safety actions advanced by the WHO across the Region. In recognition that speed is a pivotal factor in achieving a safe road and traffic system, a review of speed management in Iran was carried out in 2019 by a team of international experts in the field. The findings of this review and their implications for future actions are discussed in this paper.
246	Ainsworth, A. Coulson, R. Downing, N. Potter, C.	Indigenous Road Safety	Reviewing Queensland's indigenous driver licensing program	The overrepresentation of Indigenous Australians in road crash data highlights the need for the Department of Transport and Main Roads (TMR) to review and redevelop the Indigenous Driver Licensing Program (IDL). Over the past 12 years, the IDLP has achieved excellent results providing licence access to Indigenous communities, however the focus on road safety education under this program tends to be more adhoc. By engaging and interviewing 30 key stakeholders in Indigenous communities throughout Queensland, this research and engagement activity sought to ensure initiatives implemented by TMR (and potentially other Queensland Government agencies) were effectively targeted to achieve positive road safety outcomes for Indigenous communities. Given a driver licence is a ticket to mobility and gaining a broader experience of the world, a key outcome of the work is to provide road safety education by leveraging the reach of the IDLP in key communities earlier in the licensing journey.

247	Potter, C. Downing, N.	Motorcyclists	Motorcyclist personas: it's not one size fits all	There is support in the motorcycling community for road authorities to reconsider their approach to managing the safety of motorcyclists that accounts for the breadth of the market, as well as the differences in motivations for riding. Using a customer-centric approach, the Department of Transport and Main Roads (TMR) undertook research to understand the segments of the motorcycling community and identify different ways to engage with the community using a tailored approach.
264	Lim, H.	Road Environment	Audio tactile line-marking - mass action development and delivery	Victoria's audio tactile line-marking (ATLM) program has provided a systematic approach to the reduction of run off and head-on crashes on high risk roads. Tools and strategies were identified and utilised to ensure that benefits are realised earlier. By using rich datasets, simplifying the specification and promptly applying lessons learnt, the program was more cost effective, quicker and simpler to deliver while still treating 65% of the undivided arterial road network.
21-19	Mills, L. Freeman, J. Davey, J.	Drug Driving Drug Testing	Twelve years of roadside drug testing in Queensland: the extent and nature of recidivism	Driving with any trace of illicit drugs in one's system is against the law in all Australian jurisdictions yet thousands of offenders are detected every year through police-lead Roadside Drug Testing (RDT) operations. The results of RDT offer important insight into the nature of drug driving, however, there has been limited research evaluating the extent of drug driving recidivism. To explore this, a dataset of 67,727 drug driving offences from the Queensland Police from December 2007 to June 2020 was analysed. The results identified 50,442 unique offenders, with 25% of these offenders being detected more than once. For one-time offenders, cannabis was the most common detection. Methamphetamine was the most common drug analysis result detected across all offences, and for recidivist offenders. The results illuminate the need to explore the utility of countermeasures which focus on maximising the deterrent effect of RDT operations, and reducing offending of those already detected.
21-20	Pushka, A. Milligan, C. Turner, S.	Road Design Intersections and Roundabouts Road Safety Audit and Road Safety Review Road Safety Strategy	Comprehensive safety assessments and rapid evaluations using video analytics and conflict data: innovative approaches from North America	Towards Zero is focused on eliminating fatal and serious injury (fsi) collisions on the transportation network. Despite recent publications exploring innovative intersection design concepts following Safe System principles, there remains the need to effectively evaluate safety treatments prior to large-scale application. Video analytics and conflict data has been effectively used in North America and Europe to complete comprehensive risk assessments prior to capital investment and for rapid subsequent safety performance evaluations. In many cases this application of technology has identified latent high-risk factors previously unknown from collision data, and follow-up evaluations of safety implementations have resulted in 80-100% reductions in critical- and high-risk conflict events that are most likely to result in fsi collisions. Widespread implementation of video analytics technology with risk severity thresholds based on human impact tolerance will enable a quantitative understanding of safety measure performance, accelerate adoption of safer intersection designs and provide justification for safety investments.

21-21	Steinmetz, L. Lim, E.H.	Speed, Speeding & Travel Speeds Road Design Road Safety Programs Crash Data Analysis	Implementation and evaluation of area 40 in Maribymong – findings and lessons to date	As part of Council's Safer Local Roads program, Council has commenced implementation of 40 km/h area speed limits throughout the municipality. The City was divided into 7 areas where the sequence of Area 40 implementation generally aligns with the Local Area Traffic Management Program. To date, reduced limits have been implemented in 5 out of 7 areas – the Seddon and Yarraville precinct (Area 2), Footscray (Area 1), Kingsville (Area 3), Braybrook, Maidstone and West Footscray (Areas 4 and 7). Post-implementation evaluation forms part of this overall program. This paper presents the approach and the results of the evaluation for the first Area 40 in Seddon and Yarraville. The short-term evaluation (undertaken less than 12 months after the treatment implementation) provides insights into impacts the speed reductions have had on safety, driver behaviour and operations.
21-22	Turner, S. Sobhani, A. Wood, G. Persaud, B.	Crash Data Analysis Statistical, Epidemiology and Other Road Safety Research Methods	Improving the evaluation of Victoria's road safety program	Before and after evaluations of road safety infrastructure programs provide valuable feedback to transport departments on how effective their programs have been in reducing deaths and serious injuries. With the goal of Vision Zero it is more important than ever to understand which programs and projects are effective and those which are not. The Victoria Department of Transport have been doing evaluations of their extensive road safety programs since the 1990's. A review of the program evaluation business requirements and the methodologies that have been used to undertake previous evaluations has identified some shortcomings and potential improvements. There are best practice methods used in other countries, and especially in North America, that have been shown to provide more robust evaluation results. This study recommended changes in the statistical methods used in future evaluation studies, including use of the empirical Bayes method.
21-23	Silvester, D. Davies, R. Sobhani, A.	Road Safety Audit and Road Safety Review Crash Data Collection Crash Data Analysis Statistical, Epidemiology and Other Road Safety Research Methods	The effectiveness of the safer roads infrastructure program stage 3 (SRIP3)	This paper outlines the evaluation of the effectiveness of the Safer Road Infrastructure Program Stage 3 (SRIP3). This \$532 million road safety improvement program was implemented across 764 sites in Victoria between 2007 and 2017. The statistical analysis method used a before and after study of crashes using comparison regions to assess the reduction in casualty and serious casualty crash rates for the overall program and for various project types. Where appropriate, the efficacy of various treatment types was also assessed. The evaluation found a 27% reduction in fatal and serious casualties resulting from the implementation of the SRIP3 program, resulting in a benefit-cost ratio of 2:1. Over the expected lifetime of the projects, this corresponds to a reduction of 8300 casualties, including 3200 fatal or serious casualties. Recommendations on continuous improvement on quality of data collection and analysis are made for future evaluations.

21-24	Walker, S. Cooper, T. van Agtmaal, N. Wescombe, A.	Road Environment Statistical, Epidemiology and Other Road Safety Research Methods	Safer roads black audio tactile line marking short term evaluation	Black Audio Tactile Line Marking (ATLM) has been implemented on a range of rural roads as a component of the Safer Roads programme. ATLM is intended to reduce serious casualties caused by head-on and run-off-road crashes. A longitudinal analysis was conducted to determine if any significant change had occurred across four treatment sites and six control sites. The collection of traffic data included Automatic Traffic Counts (ATCs) and video camera surveys to observe driver speed behaviour and lane placement. The camera survey sites provided the most tangible evidence that the Black ATLM treatment is effective at modifying driver behaviour. Lane positioning variability significantly reduced in at least one direction at the treatment sites, compared to none at the control site. Similarly, duration of lane encroachment and passing vehicle separation had some significant results at the treatment sites, however more data is needed to verify the ATLM impact on these variables.
21-25	Davy, S. Cairney, P. Lawrence, B. Fildes, B.	Speed, Speeding & Travel Speeds Road Environment Road Design Intersections and Roundabouts	Short-term evaluation of raised safety platforms: a preliminary analysis based on vehicle speeds	Raised Safety Platforms (RSPs) have been installed to reduce the speed of traffic entering intersections with a view to reducing fatal and serious injury (FSI) crashes. A before and after study with control sites was used to compare traffic performance prior to and after the installation of RSPs at treated intersections along two arterial routes. Statistically significant reductions in speed were found at all treated intersections, and in most cases these reductions were substantial. After treatment and adjusting for changes in the control group, there was an 80% reduction in the odds of a vehicle on the main road exceeding the Safe System threshold of 50 km/h for cross-traffic collisions - the percentage of vehicles exceeding this speed reduced from 32% to 7%. There was also a 46% reduction in the odds of exceeding 30 km/h. Crash reductions estimated on the basis of the speed reductions were 24% for vehicle to vehicle crashes. Substantial reductions in the risk of injury to vulnerable road users and other dominant crash configurations were also identified. It was concluded that RSPs were an effective countermeasure for intersections, and that they could be used in similar situations with confidence, but long-term monitoring was required to determine their crash reduction factor based on real crashes.

21-26	Turner, S. Alavi, H. Sobhani, A.	Policy Development And Implementation Crash Data Analysis Statistical, Epidemiology and Other Road Safety Research Methods	Developing safe system projects and programs using safety science methods	The Victorian Safer Roads program strives to eliminate road traffic fatalities and serious injuries across the State through the cost-effective implementation of safe system compliant road safety infrastructure and speed management programs and projects. To maximise the benefits of the Safer Roads program it is important that any safety countermeasures are well targeted to the highest risk sites and routes. This relies on using statistically robust methods in both site selection and project appraisal, that adequately account for statistical variation in crash data. This study identified the gaps/weaknesses in the current road safety project and program development methods used by Safer Roads and assessed the various options that are available to address these shortcomings. This study established the need to move away from relying solely on historical crash data and a move towards the empirical Bayes method, that use both historical crash data and predictive crash analysis methods, based on safety performance functions (SPFs) and crash modifying factors (CMFs). This preferred method is often referred to as the safety science, or the USA Highway Safety Manual (HSM), approach.
21-30	Mustafa, M. Bakar, H. Mohammad, M.Z. Azmi, E.A. Ja'afar, M.S. Ibrahim, A.	Driver Risk Workplace and Work Related Road Safety Road Safety Programs Education – general and other	Vision zero for P-Hailing riders: understanding work demands and unsafe work behaviours	Looking at worrying trend of accidents among p-hailing riders, which refers to the delivery of parcels and food via online applications using motorcycles, it is essential for us to set out strategy to curb the accidents. As part of Malaysia's Vision Zero Program, this study identifies the roles of working conditions in influencing their safety risks and examines how safety becomes riders' top priority. An online survey was conducted and the results of 100 respondents showed that the desire to get attractive income has forced them to work long hours with insufficient rest time and persuade them to violate traffic rules more often. Besides, the riders ride dangerously at peak hours to avoid negative response from customers. The findings will be used as baseline information for conducting training to increase riders' safety awareness in line with the government strategies on regulating the service under existing laws.
21-32	Trivedi, P. Shah, J.	Road Safety in Developing Countries Crash Data Analysis Data Linkage Statistical, Epidemiology and Other Road Safety Research Methods	Identification of road accidents severity ranking by integrating the multi-criteria decision making approach	This research aims to advance a novel road accident severity ranking integrating the injuries types. The injury severity data of 29 numbers of Indian states (i.e. Andhrapradesh, Arunachal Pradesh, Bihar, etc.) for the year 2019 was incorporated to formulate the severity ranking by using Multi-Criteria Decision Making (MCDM) methods. Analytical Hierarchy Process (AHP) and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) methods were taken into the application for research synthesis. The integration of MCDM methods incorporates the injury severity data with the ranking analysis. Further analysis proved the validity of the proposed research by collectively analyzing the variety of injury severity data within the single ranking approach, which often analyzes individually. Therefore to develop a novel approach, this research is resulted with great accuracy and has a great potential for reforming the conventional severity ranking practice.

21-47	Lindner, H. Clarkson, E. Black, M.	Advocacy Child Restraints Crash Testing Safer Transport & Mobility	Safety for all: building an evidence base to support safe vehicle transport for children with disabilities and medical conditions	Recent research shows lack of improvement in the transportation of children with disabilities, noting they 'continue to be inappropriately restrained in vehicles, constituting an ongoing road safety problem.'. Mobility and Accessibility for Children in Australia (MACA) was established in 2019 to close this gap. MACA initiates research and develops policies, resources, and programs to empower a whole of system approach to meeting the transport needs of children with disabilities and medical conditions. This presentation will include key findings from MACA's national survey, undertaken by Curtin University. The largest and most comprehensive survey of its kind in Australia, the findings reveal stark road safety challenges for families and children with disabilities and medical conditions. It will also introduce MACA's new Australian Safety Assessment Program, funded by the TAC and supported by NeuRA and Britax. This world leading program develops information and prescribing advice based on assessment (including sled-crash testing) outcomes.
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## M7 to M2 Pre-congestion Speed Management

Timothy Clark, Sam Gray

Transurban

### Abstract

This paper explores the development and implementation of the M7 to M2 Pre-congestion Speed Management trial. This trial was the first of its kind in NSW and will allow motorway operators and road authorities the opportunity to understand the safety and reliability benefits that proactive speed management may bring to Sydney's motorway networks

### Background

The M7 experiences eastbound workday morning congestion at the M2 interface with the Abbott Road onramp. This merge causes flow breakdown resulting in queuing that regularly extends back from the M2. Previously to deal with this congestion the Variable Speed Limit Signs (VSLS) dropped speeds once queuing had formed and provide advanced warning notification on the Variable Message Signs (VMS) reducing the speeds of vehicles approaching the back of queue.

Recently a trial was undertaken to 'proactively' reduce speeds as mainline speeds dropped but before queuing formed in an attempt to increase road safety, improve motorway flow and delay the onset of flow breakdown.

Using speed information from inductive loops on the motorway it was found that proactively reducing speeds has slowed the rate of change in speed drop, as well as slightly reducing the overall extent of congestions. Additionally there has a positive impact to safety where during the first 6 months of the proactive speed trial congestion related crashes within the area dropped from 5 (over the same 6 month period in the previous year) to 0.

<https://www.rms.nsw.gov.au/about/news-events/news/roads-and-maritime/2018/180615-trial-smart-technology-m7-motorway.html>

<https://www.westlinkm7.com.au/news/westlink-m7-proactive-speed-limit-trial--bella-vista-to-baulkham>

## Paradigm Lost – Getting Beyond the Safe System

Rob Morgan

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### Abstract

Every new road safety paradigm is ultimately counter-productive, because it becomes dogma. The *Safe System* and strategies based on it, like *Towards Zero* have repeated this truism. Zero is not possible. Pursing it has involved a return to pre-scientific notions of road safety ‘solutions’ that are ineffective. For example, the ‘primacy of speed management’ in all Australian road safety strategies has resulted in excessive use of low speed limits – an example of trying to directly modify road user behaviour. The Safe System’s core (the body’s tolerance to crash forces) is useful, but is only half the story. The other half is the mind’s tolerance to complexity and excessive, wrong or misleading information. The author has developed an alternative evidence-based strategic framework. It seeks to avoid dogma. It incorporates the need to understand human behaviour, rather than fight against it. This alternative is the *Safety Star System*. Details are included.

### Extended Abstract

Dogma is inherent in the *Safe System* and strategies like *Towards Zero*, as they set an absolute objective (zero fatalities and serious injuries (FSIs)) without any credible mechanism to achieve it.

Elements of dogma include:

- Focusing on one element as the primary solution to a complex set of problems (‘the primacy of speed management’),
- Discarding evidence-based and rational experience (e.g. discarding 85<sup>th</sup> percentile speeds as the basis for speed management), and
- Returning to discredited approaches, such as seeking to directly modify road user behaviour.

Haight (1994) referred to the public policy dilemma of seeking to maximise safety, maximise mobility and minimise cost. Two can be substantially achieved at the expense of the third. The Safe System dismisses mobility as if it has no value; safety is paramount.

Despite being paramount, safety has fared worse. In the seven years *before* Victoria adopted its *Towards Zero* strategy in August 2015, the number of serious injuries (‘acute hospitalisations’) was 5,200 - 6,000 p.a.. In the 4 years of data *after*, it’s risen to over 8,000 p.a. (TAC, 2020). That’s 33% more, not 15% fewer (2015 state target), or 30% fewer (2010 national target) - despite more funding, and greater driver restrictions and penalties.

More FSIs will be eliminated if we look at *all* crashes, not just fatal and serious crashes. But that requires good data, which is no longer available. We have little idea what’s happening on the roads. Data needs are not part of the Safe System; nor are skills and experience. Road safety engineering skills are now so poor and Safe System dogma so entrenched that the new road safety audit guidelines (Austroads, 2019) state ‘The focus of the audit will be to consider ... fatal or serious injuries and kinetic energy generation ...’. This should be of grave concern.

As a road safety engineer/auditor, I apply knowledge of road user behaviour. The Safe System pillar ‘Safer road users’ doesn’t include this; it’s principally about road users being alert and compliant. The Safe System’s core (the body’s tolerance to crash forces) is only half of what I deal with. The other half is the mind’s tolerance to complexity and problematic information.

These fundamental flaws in the Safe System led me to develop an alternative strategic framework. I call it the *Safety Star System*. The top of Figure 1 shows its undogmatic over-arching philosophy. Its core has two parts (the limits of the human mind and the limits of the human body). It has six star points/areas of action (equivalent to pillars) where responsibility is to be encouraged. The required resources/inputs are shown. The three most important ones (road user behaviour, risk and crash analysis) are shaded. The Safe System is endorsed as the way to achieve ‘zero’. It must thus contain all the answers. My alternative does not: adjustments will be needed as new understandings emerge.

I thank the reviewers of my submitted abstract. I address their points in a full paper (not published with this conference), available at <https://sites.google.com/view/robmorgan/free-downloads>

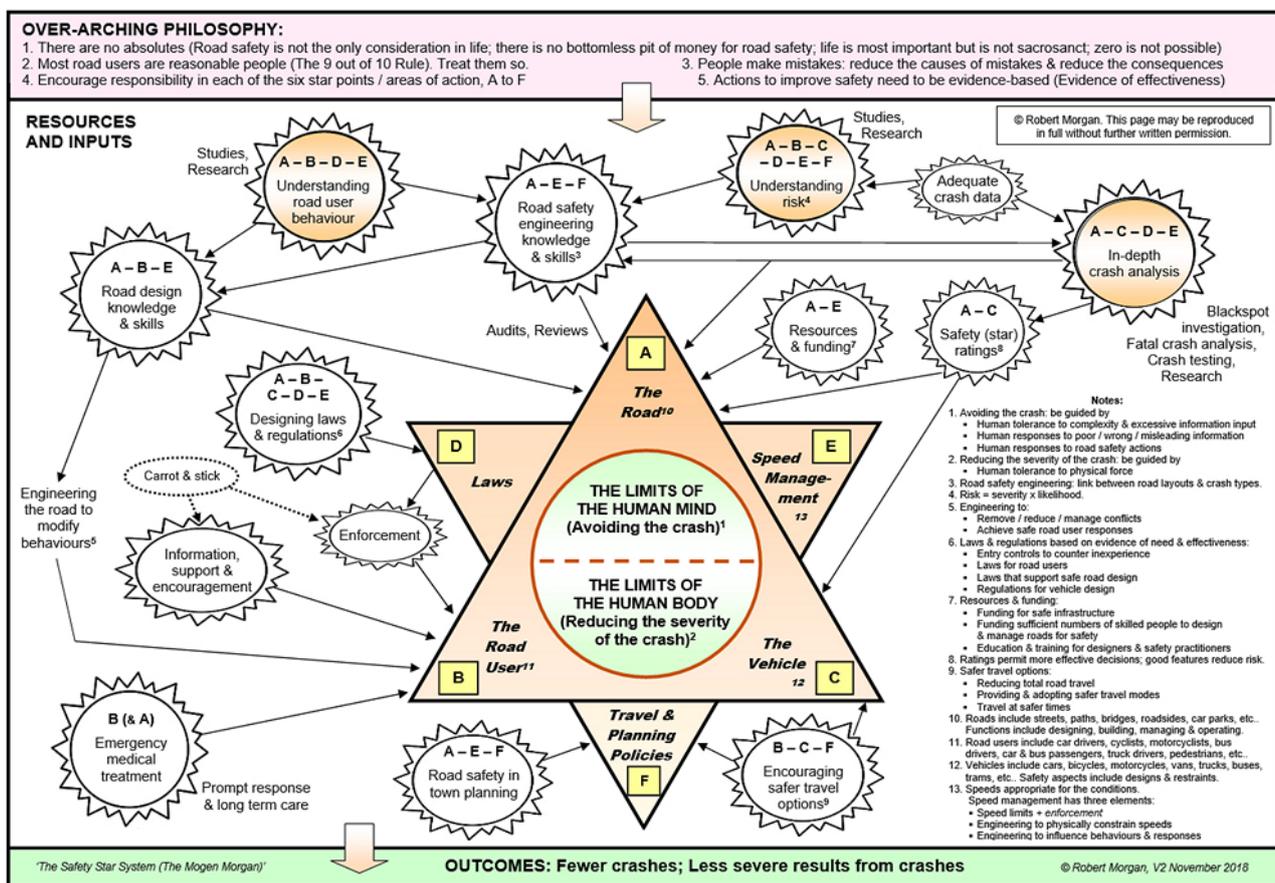


Figure 1. The Safety Star System, a new strategic framework

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## A Safe Access Audit Tool for Active Transport

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### Abstract

Safe System Solutions Pty Ltd and Victoria Walks worked in partnership to develop a comprehensive auditing and decision support tool on behalf of Banyule City Council. Banyule require the tool to enable them to conduct in-house safe access audits of some of their activity centres in relation to pedestrians, cyclists and mobility scooter users. The tool itself consists of four modules providing 1) criteria checklist, 2) report template for site visits, 3) strategic overview template, 4) a template for recording final decisions.

### Background

Safe System Solutions Pty Ltd and Victoria Walks worked in partnership to develop a comprehensive auditing and decision support tool on behalf of Banyule City Council. Banyule require the tool to conduct safe access audits of their activity centres in relation to pedestrians, cyclists and mobility scooter users.

The tool has been developed to enable Council officers to prepare reports on, and make comparisons between, different activity centres and to determine what (if any) infrastructure treatments may be needed. It achieves this by guiding practitioners through the process of conducting a comprehensive technical audit of conditions relating to safe access as well as considerations relating to community sentiment and planning priorities.

### Output

The Safe Access Audit Tool that was developed consists of four modules:

1. A list of criteria to check when conducting a site audit
2. A report template to record key issues and recommendations resulting from the site visit
3. A report template to create a strategic overview of the site that includes engineering recommendations, community sentiment, alignment with government planning and prioritisation.
4. A report template to enable comparison of different sites and record decisions made by the infrastructure manager

### Methodology

Previous experience in road safety auditing provided the project team with the basis for the tool. In relation to walking and mobility scooter access, the tool was based on the framework developed by Victoria Walks for the 20-Minute Neighbourhood Pilot Program, led by the Victorian Department of Environment, Land, Water and Planning. This provides a detailed checklist of considerations to allow a general assessment of walkability including access for people with impaired vision or using wheelchairs, prams or mobility scooters (without formally assessing compliance against the Disability Discrimination Act 1992).

In relation to cycling, a desk study of safety factors, auditing methods and best practice methodologies helped refine the criteria checklist and core reporting format. This covered the main aspects of reporting engineering and road safety issues. Uniquely, additional consideration was given to how community engagement and government planning should influence prioritisation and decisions on implementation of audit findings. A prototype tool was developed, then tested and refined through application at four activity centres.

The Tool recognizes the quite different needs and considerations of walking (including mobility scooters) and cycling, but brings them together in a consistent framework. The examples below illustrate firstly the way checklist considerations are framed, followed by part of the framework used to summarise results.

**Table 1. Examples of some of the criteria within Module 1 for the Safe Access Audit Checklist for Cycling**

	<b>Coherence</b>	<b>Rideability</b>	<b>Safety</b>
<b>Criteria 1</b>	Is the route as direct as practicable given hills and major intersections?	Does the quality of the riding surface meet satisfactory standards?	Where paths are located adjacent to roads, is there sufficient separation and/or protection from the roadway?
<b>Criteria 2</b>	Can cyclist speed be maintained for majority of the route?	Are sealed shoulders at least as smooth as traffic lanes?	Can utility service covers, grates, drainage pits etc. be safely negotiated by cyclists?
<b>Criteria 3</b>	Is the route supported by coordinated systems such as signs and markings that are clear and easy to follow?	Are paths wide enough for the pedestrian and cyclist volumes?	Are signs, bus shelters and street furniture sited to avoid obstructing the passage of cyclists?
<b>Criteria 4</b>	etc	etc	etc

**AREA/ROUTE/LOCATION 1 – ASSESSMENT WALKING AND MOBILITY SCOOTERS (repeat table for area/route/locations 2,3,&4)**

CRITERIA	NOW			FUTURE			COMMENTARY
Community Support	L	M	H	L	M	H	Summary of issues relating to community opinion of current conditions and support for change: <ul style="list-style-type: none"> <li>Consider opinions of community and businesses (both local and remote)</li> <li>Consider opinions of safety stakeholders such as DoT, Police, SES, CFA interest/lobby groups etc</li> <li>Is there support - proactively or in principle?; Or is there opposition - proactively or in principle?</li> </ul> > Cost Guidance – Is funding required for any communication and engagement activity?
Strategic Imperative	L	M	H	L	M	H	Summary of strategic motives for making safe access improvements: <ul style="list-style-type: none"> <li>Are improvement outcomes desired and promoted by federal, state or local government?</li> <li>Identify policies, strategies, plans and commitments that are explicitly supported by these outcomes</li> <li>Is this a Principal Pedestrian Network. What are the key travel generators in the area?</li> </ul> > Cost Guidance – Are there available budgets or funding sources?
Place Experience	L	M	H	L	M	H	Summary of how area and recommendations support desirable attributes for place experience (see audit checklist) and particularly: <ul style="list-style-type: none"> <li>Perceived personal safety and security</li> <li>Weather protection</li> <li>Street furniture and facilities</li> </ul> > Cost Guidance – Estimate of total combined treatment costs
Walkability	L	M	H	L	M	H	Summary of how well the route and recommendations support desirable attributes for walkability (see audit checklist) including: <ul style="list-style-type: none"> <li>Quality and service levels of infrastructure and comfort level</li> <li>Ease of clear and unimpeded movement</li> <li>Legibility and connection of footpaths – clearly marked and segregated</li> </ul> > Cost Guidance - Estimate of total combined treatment costs
Safety	L	M	H	L	M	H	Summary of how well the route and recommendations support desirable attributes for safety and address risks of fatal and serious injury (see audit checklist) and particularly: <ul style="list-style-type: none"> <li>(primary concern)</li> <li>Pedestrian priority and provision for crossing streets, particularly major roads</li> <li>Interaction with traffic</li> <li>Surface quality and risk of trips and falls</li> </ul> > Cost Guidance – estimate of total combined treatment costs
Cost Overview				H	M	L	Estimate of total costs for all improvements

**Figure 1. Strategic overview safe access for a single activity centre. This comprises Module 3.**

**Next steps**

The tool was developed in collaboration with a Council Working Group that also provided site-specific input on the centres in question. Local stakeholder input included consultation with the local traders’ associations and representatives from the local community, including older people and those with impaired mobility. Community representatives joined the audit team to provide feedback on the ground and better understand the audit process, in testing the first version of the tool.

The success of the tool depends, in the final analysis, on the ability of Council officers to use it in-house. Preliminary results indicate that it is successful in this respect.

**Acknowledgements**

Safe System Solutions Pty Ltd and Victoria Walks would like to thank Banyule City Council for sponsoring this project and supporting development of the Safe Access Audit Tool.

## Audio-tactile Line-marking and Perceived Motorcycle Stability

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<sup>a</sup> Safe System Solutions Pty Ltd, <sup>b</sup> Transport for New South Wales

### Abstract

Audio-Tactile Line-Markings (ATLM) are a road safety feature designed to alert vehicle drivers and avoid lane departures by creating a haptic and audible vibration. There have been concerns by motorcyclists that ATLM could negatively affect the stability of motorcycles. This study qualitatively assesses whether ATLM negatively affect motorcycle stability. Three ATLM configurations were installed and 10 participants were recruited to ride over the ATLM and provide feedback through surveys. The results from the survey analysis indicates that the participants' perception of ATLMs as a potential cause of motorcycle instability had decreased.

### Background

Audio-Tactile Line-Markings (ATLM) are a road safety feature designed to alert drivers to lane departures. ATLM create a haptic and audible vibration through the vehicle that is designed to awaken and alert inattentive drivers.

In May 2018, the Motorcycle Club of NSW raised concerns about ATLMs in the centre and side lines of two sections of the Oxley Highway, saying that they were slippery, dangerous and "madness". In response to such concerns, Transport for NSW engaged Safe System Solutions Pty Ltd to conduct a qualitative study to determine whether motorcycle riders' perceive ATLM to have a detrimental effect on motorcycle stability.

### Method

#### *Study Location & ATLM Installation*

Three ATLM configurations were installed in outdoor asphalt sealed surface testing grounds at CrashLab, the NSW Government's vehicle and transport system testing facility. To make sure that the ATLMs used in the test replicate those on the road, an experienced ATLM installation contractor was hired to install them at CrashLab. The configurations were: a straight line of 60m, an arc with a 13.1m radius, and an arc with a 52.5m radius (See yellow, blue and red line in Figure 1, respectively).



**Figure 1. Installed ATLM configuration**

The straight ATLM is representative of ATLM installed on straight sections of roads and the two ATLM arcs were chosen as it was anticipated that small radii bends may affect motorcycle stability more than larger radii bends). Riders traversed the ATLM as they would on the road – in a transverse direction – allowing for some angled approach to replicate a motorcycle departing the travel lane. Participants were asked to interact with the ATLMs to replicate potential real-world situations (e.g. braking while riding over ATLMs, accelerating while riding over ATLMs, cornering while riding over ATLMs, etc.).

### ***Study Phases***

This study was conducted in two phases with the same methodology and variables except for: (a) rider experience and (b) motorcycle engine capacity. In Phase 1 (Figure 2), experienced riders ( $\geq 10$  years of riding experience) and motorcycles with medium to large engine capacity (500cc to 1300cc) were included in the study. In Phase 2 (Figure 3), less experienced riders ( $\leq 6$  years of riding experience) and motorcycles with small/medium engine capacity (125cc to 700cc) were included in the study. A total of five riders participated in each phase and all riders consented to participating in the study.



**Figure 2:** ATLM Study Phase 1 with experienced riders



**Figure 3:** ATLM Study Phase 2 with less experience riders

The study proceedings are summarised in chronological order below:

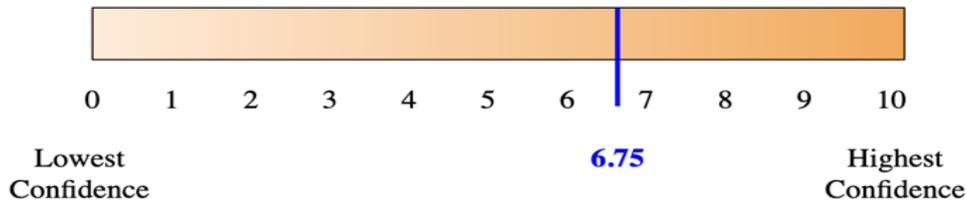
- **Pre-trial survey** - A survey was completed by the participants to determine their road riding confidence levels in various conditions and their perception of ATLM.
- **ATLM trial part 1** - Participants rode over ATLM in dry conditions with speeds between 15km/h to 95km/h.
- **ATLM trial part 2** - Participants rode over ATLM in wet conditions with speeds between 15km/h to 80km/h
- **Post-trial Survey** - A survey was completed by the participants after the trial component to determine if their perceptions of ATLM had changed.

The survey questions asked the rider to rate, on a scale of 0 to 10, their ability to maintain control of their motorcycle.

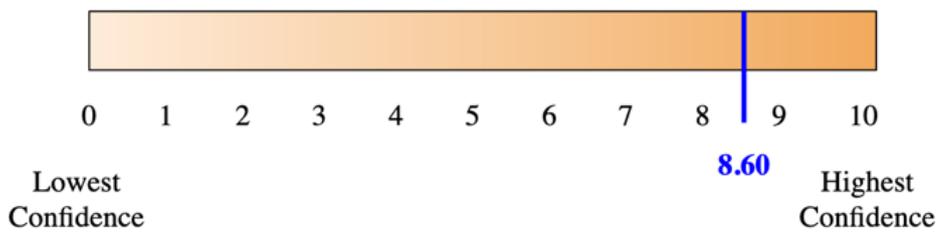
**Results**

***Pre- and post-trial Survey Results***

The results from the pre- and post-trial survey for Phase 1 of the study is presented in Figure 4 and Figure 5, respectively.

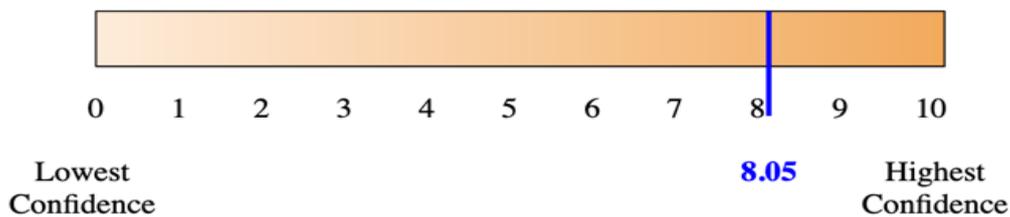


*Figure 4 Phase 1 participants’ aggregated confidence level on riding over ATLMs in dry road conditions pre-trial (sd = 1.55)*

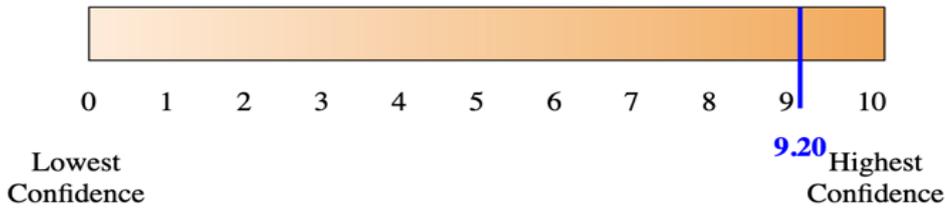


*Figure 5 Phase 1 participants’ aggregated confidence level on riding over ATLMs in dry road conditions post-trial (sd = 0.85)*

The results from the pre- and post-trial survey for Phase 2 of the study is presented in Figure 6 and Figure 7, respectively.

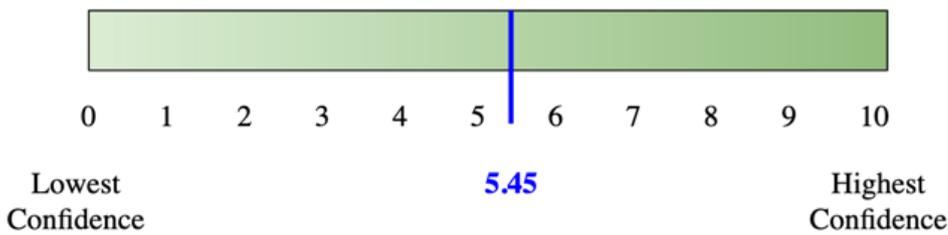


*Figure 6 Phase 2 participants’ aggregated confidence level on riding over ATLMs in dry road conditions pre-trial (sd = 1.09)*

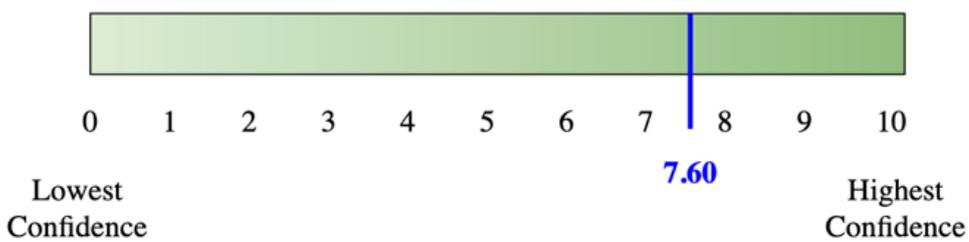


*Figure 7 Phase 2 participants’ aggregated confidence level on riding over ATLMs in dry road conditions post-trial (sd = 1.03)*

The results from the pre- and post-trial survey for Phase 1 of the study is presented in Figure 8 and Figure 9, respectively.



*Figure 8 Phase 1 participants’ aggregated confidence level on riding over ATLMs in wet road conditions pre-trial (sd = 2.84)*

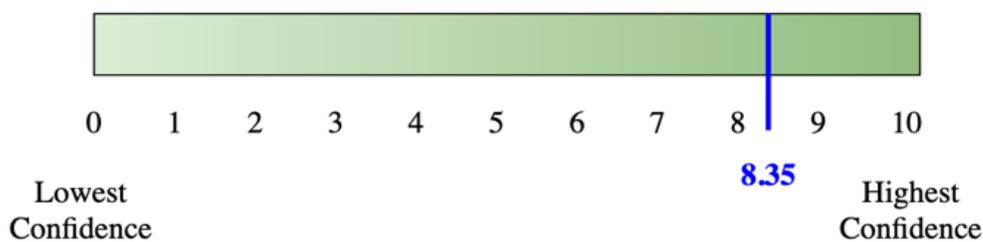


*Figure 8 Phase 1 participants’ aggregated confidence level on riding over ATLMs in wet road conditions post-trial (sd = 0.59)*

The results from the pre- and post-trial survey for Phase 2 of the study is presented in Figure 9 and Figure 10, respectively



*Figure 9 Phase 2 participants' aggregated confidence level on riding over ATLMs in wet road conditions pre-trial (sd = 1.27)*



*Figure 10 Phase 2 participants' aggregated confidence level on riding over ATLMs in wet road conditions post-trial (sd = 1.04)*

## Discussion

Feedback from riders indicated that prior to this study most of them strenuously tried to avoid riding over an ATLM because of the widespread belief that they are slippery and dangerous. Though one could argue that anything that encourages greater vigilance on the part of motorcycle riders is to be commended, it was decided that encouragement of a false belief is self-defeating and that motorcycle riders should be made aware that the ideal of slippery and dangerous ATLMs is a myth.

## Conclusions

The results from the pre- and post-trial survey analysis indicates that the participants' perception of ATLM as a potential cause of motorcycle instability had decreased. This result applies to both dry and wet road conditions. The lower perception of risk indicates that there is a difference between rider perception and actual experience of riding over ATLM.

In practice it means that though motorcyclists should continue to be encouraged to ride within lanes and thus avoid ATLMs, they need to be made aware that motorcycles continue to be stable and controllable should they inadvertently stray over an ATLM.

## Acknowledgements

We would like to acknowledge Cassidy Southern and Carlos Brito from Transport for New South Wales for their contribution to this study.

## **An Evaluation Of Retro-Reflective Screens To Aid Conspicuity Of Trains At Passive-Control Level Crossings At Night**

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(Also see: <https://doi.org/10.33492/JRS-D-21-00007>)

### **Abstract**

Trains already passing through level crossings in rural areas at night can be difficult for approaching motorists to see. Crashes can occur if the crossing has ‘passive’ controls (Give way/Stop signs) and motorists fail to stop. Retro-reflective screens on the far side of the crossing to motorists that reflect headlights and produce a ‘strobing’ effect between carriages could increase train conspicuity. A prototype screen was applied to a crossing in South Australia. Four videos of trains at night from the perspective of an approaching vehicle (conditions: high versus low beam headlights, screen versus no screen) were recorded and used in a reaction time experiment with  $N=29$  drivers. With high beams, the screen led to shorter reaction times, which suggests it increased train visibility. With low beams, it led to longer reaction times, which suggests it reduced train visibility or confused drivers. Implications, study limitations and further experimental testing are discussed.

### **Background**

In urban areas of Australia level crossings between railways and roads have ‘active’ controls (flashing lights, warning sounds, boom barriers). However, many crossings in rural areas have ‘passive’ controls (Give way/Stop signs), which present greater potential for human error. If the road user fails to stop and check for trains a crash may occur. Trains already passing through crossings in rural areas at night can be difficult for approaching motorists to see. There are approximately 6,000 passive level crossings in Australia (Australian Transport Safety Bureau, 2008). It would be an expensive and long process to upgrade all passive crossings to active crossings. A less expensive, ‘passive’ solution that could improve train conspicuity at night is the use of retro-reflective screens on the far side of the crossing to approaching vehicles that reflect headlights and produce a ‘strobing’ effect between carriages (White et al., 2015). This study produced a prototype screen and evaluated its effectiveness.

### **Method**

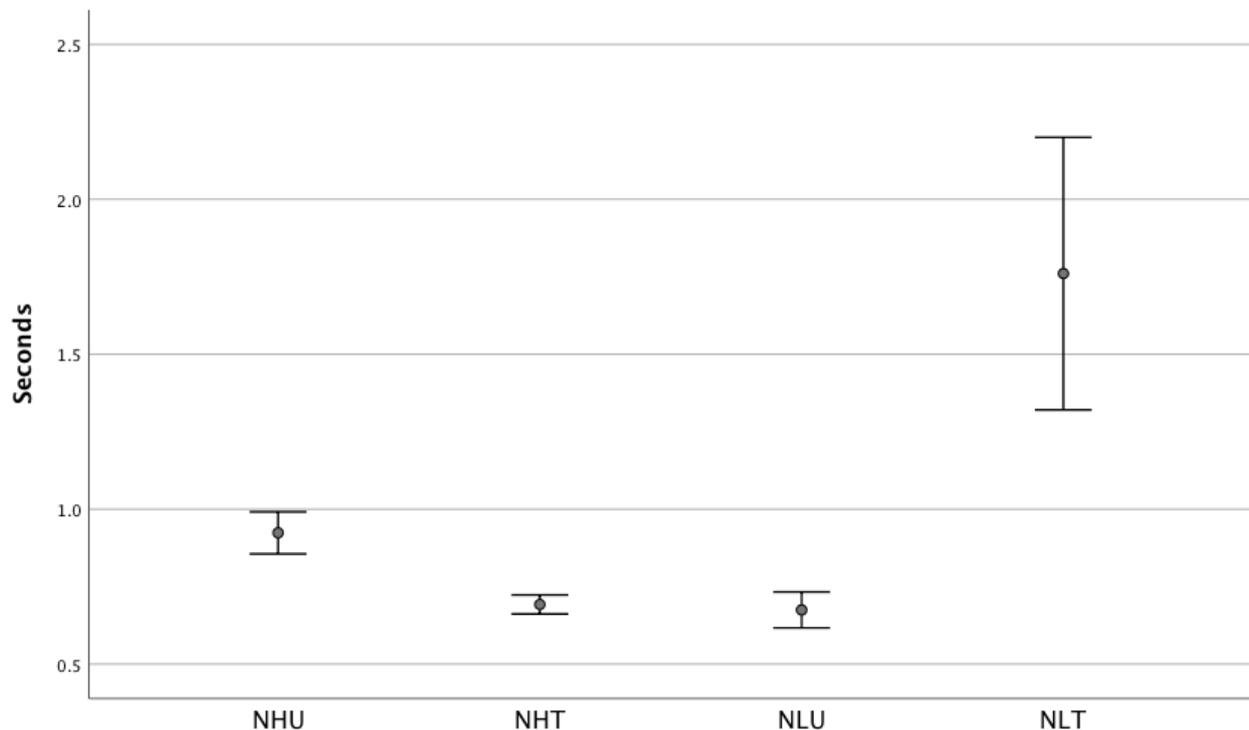
The prototype (1,230mm high by 200mm wide) was made of diamond-grade material. It was applied to a crossing in South Australia and the following four videos of passing trains from the perspective of an approaching vehicle were created:

- NHU: night, high beams, untreated (no screen).
- NHT: night, high beams, treated (screen).
- NLU: night, low beams, untreated.
- NLT: night, low beams, treated.

These were used in a reaction time computer experiment with a convenience sample of fully licensed drivers ( $N=29$ ). The aim was to determine whether drivers react to trains faster when the screen is in place compared to when it is absent.

## Results

Mean reaction times to the videos are in Figure 1. Repeated-measures Analysis of Variance found that main effects of vehicle headlight ( $F(1,27)=14.29, p=0.001, \eta^2=0.346$ ) and presence of the screen ( $F(1,27)=16.28, p<0.001, \eta^2=0.376$ ) and the interaction between these ( $F(1,27)=38.80, p<0.001, \eta^2=0.590$ ) were statistically significant. With high beam headlights, the screen led to shorter reaction times (NHU compared to NHT), which suggests it increased train visibility. With low beams, the screen led to longer reaction times (NLT compared to NLU), which suggests it reduced train visibility or confused drivers. Pairwise comparisons showed that all means significantly differed ( $p<0.008$ ), except NHT and NLU.



*Figure 1: Mean reaction times and 95% confidence intervals*

## Conclusions

The detrimental effect of the screen with low beams could be, at least partly, due to methodological limitations relating to differences between trains in the videos, the instructions given to participants, and the degree to which the experiment replicated real-world driver behaviour. However, the screen may genuinely have confused or distracted participants and may do so in real-world conditions. Further experimental testing would be required to determine whether the results in low beam conditions persist. If they do, efforts to increase safety at passive level crossings at night should be directed towards other countermeasures, such as:

- Lights and/or retro-reflective material applied to the sides of trains.
- Reduction of speed limits on approaches to level crossings.
- Elimination of Give way signs in favour of Stop signs.
- Additional illumination of the crossing.

**References**

- Australian Transport Safety Bureau. (2008). *Railway level crossing safety bulletin*. Canberra, ACT: Department of Infrastructure, Transport, Regional Development and Local Government.
- White, M., Baldock, M. R. J., Woolley, J. E., Stokes, C. S., Royals, J., & Sommariva, M. (2015). *Passive solutions to improve the conspicuity of tabletop carriages at railway level crossings at night* (Report no. LC11). Canberra: Australian Centre for Rail Innovation.

## Pedestrian Occupancy Detection (POD) Using an Optical System at Traffic Signals

Elizabeth Lee<sup>a</sup> and Anthony Fitts<sup>a</sup>

<sup>a</sup>State Government of Victoria

### Abstract

The Department of Transport has approximately 3350 traffic signal intersection in Victoria where around 1500 are Pedestrian Operated Signal (POS) and 325 are Pedestrian User Friendly Intelligent (PUFFIN) crossings using overhead radar detectors to optimise the pedestrian signal settings. The PUFFIN detectors are used to detect all pedestrians crossing the carriageway. The output is used by the traffic signal controller to extend the walk and/or clearance times while a pedestrian is on the crossing. However, there is no information on how many pedestrians and cyclists are waiting to cross. The testing of POD using an Optical system can be used to detect and monitor the volumetric data in the form of pedestrian occupancy ratio in a predetermined area. The main feature is the occupancy mode which allows traffic signal operation to be dynamically adjusted dependent on the volume of people waiting to cross. This is ideal for sites which have varying influx of people using the crossing e.g. school.

### Background

The type of operational improvements for pedestrians being tested with the POD are longer walk and clearance times to cater for large number of pedestrians and cyclists. When the occupancy ratio is high, to avoid pedestrians spilling on to the roadway, the signal operation can be dynamically adjusted to operate more pedestrian movements and increased walk and clearance times. For very wide crossing areas, when a pedestrian is detected in the wait zone, a demand for the pedestrian movement can be placed rather than pedestrians required to press the pedestrian push button.

A virtual detection zone of 30m<sup>2</sup> can be set up over an area where pedestrians are waiting for a pedestrian phase. The detection zone can be mapped for any regular or irregular shaped waiting areas. The time it takes to draw up the virtual detection zone is very simple and changes to the zone can be made when necessary.

The purpose of the trial was to determine the effectiveness and reliability of the Pedestrian Occupancy Detector operation and if the information on pedestrian occupancy can be used to improve the level of service and safety for pedestrians.

Under Creating More Road Space program, the POD detectors are being installed to improve safety for pedestrians by managing conflicting vehicle movements, demanding pedestrian movements at sites where there is auto introduction for religious reasons and cater for very large groups of pedestrians arriving at pedestrian crossings. These techniques will be presented in more detail.

## **The Effect of Parenting Styles and Differing Theoretical Frameworks on Young Drivers Self-Reported Compliance**

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<sup>a</sup>Griffith Criminology Institute and School of Criminology and Criminal Justice, Griffith University, Brisbane, Australia

### **Abstract**

New drivers are a high risk group for traffic offences. With traditional deterrence appearing to have a more limited impact on young drivers, effective alternatives are needed. The purpose of this study was to identify if parenting style influenced self-reported offending after considering different types of theoretical frameworks. An online vignette study was completed by 1,673 participants who held a provisional (Queensland) or probationary (Victoria) licence. The scenarios were based on deterrence, procedural justice, and third party policing frameworks. In addition to a general decrease in offending, participants that reported having parents that were higher in control indicated that they were less likely to offend when exposed to the third party policing scenario. These results indicate that third party policing has potential to improve compliance rates for young drivers and that it is important to consider parenting style when introducing initiatives designed to increase young driver compliance.

### **Background**

Newly licensed drivers are a high risk group for traffic offences. Linked to this, the group is over-represented in vehicle crashes. This group's noncompliance has been shown to be more resilient to the effects of deterrence based initiatives than other groups. Procedural justice and third party policing are two theoretical frameworks that may help to address this issue. The purpose of this study was to identify if parenting style influenced the impact of deterrence, procedural justice and third party policing had on self-reported offending.

### **Method**

An online survey containing an experimental vignette study was completed by 1,673 participants who held a provisional or probationary licence from two Australian states: Queensland and Victoria. Of the participants 68.7 percent were female and the mean age was 19.81 years (sd = 2.09). All participants were in the first three years of driving. The scenarios were based on deterrence, procedural justice, and third party policing frameworks. Of the participants, 39.3% had parents who were rated as having a high control parenting style and 50.6% had parents who were rated as being high in support.

### **Results**

Participants did not indicate that their offending behaviour was affected when exposed to either the procedural justice or third party policing scenario regardless of whether their parents had a supportive style or not. However, parents with a controlling style impacted the participants' reaction to third party policing. When exposed to third party policing, participants whose parents had a parenting style high in control indicated that they were significantly less likely to offend. This was the only situation in which third party policing was reported to affect offending. This was in addition to a general reduction seen for both parenting styles when using the deterrence framework. Neither parental support nor control levels appeared to significantly alter this effect.

**Conclusion**

With previous evidence that traditional deterrence has a limited effect on young drivers, effective alternatives are valuable. These results indicate that third party policing has capacity to improve compliance rates for young drivers depending on how parents interact with their children. The results also suggest that it is important to consider parenting style when introducing initiatives designed to increase young driver compliance. Third party policing shows further potential to work alongside a traditional deterrence framework.

## **Increasing the effectiveness of mobile speed cameras on rural roads in Victoria based on crash reductions from operations in Queensland**

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<sup>a</sup>Monash University Accident Research Centre

(Also see: <https://doi.org/10.33492/JRS-D-20-00273>)

### **Abstract**

Mobile speed cameras on Victoria's rural roads are not as effective as they could be due to the site selection criteria, the limited number of sites, and the visibility and predictability of their enforcement operations. Queensland's overt mobile speed cameras achieve substantial crash reductions up to 4 km from rural camera sites due to site selection based only on crash history and randomised scheduling of operations to those sites. New sites in Victoria should be selected as in Queensland and camera visits should be randomly-scheduled. The Victorian Government's announcement to increase mobile speed camera hours by 75% should take the form of at least 75% increase of rural sites. The new sites should be selected on the basis of a serious crash history within 2.5 km. Mobile speed cameras operated at these new rural sites could be expected to save 22.5 fatal crashes and 172 serious injury crashes per year.

### **Background**

Sites for mobile speed cameras in Victoria are chosen by their serious crash or speeding history, and the physical criteria for operation of a mobile camera unit. The Victorian Auditor General's Office (VAGO 2011) expressed a concern that narrow site selection criteria can limit the extent to which mobile cameras have an area-wide effect. If there is a systematic pattern of deployment of mobile cameras, regular road users can identify this and adjust their behaviour where a camera is likely to be. Siting of mobile camera operations based on physical criteria alone might reduce the likelihood of an identifiable pattern.

In response to a VAGO (2011) recommendation, Victoria Police conducted a trial of mobile speed camera deployments based only on the physical field criteria during 2014-2015. In three Police Divisions, the number of MSC sites was approximately doubled by choosing new sites without any constraint to needing a history of serious crashes or speeding. There was 5% reduction in casualty crashes in the lower speed limit zones of the trial Divisions (Cameron, Newstead and Budd 2019). There was no additional effect on crashes on roads with higher speed limits, principally rural roads. There was no disadvantage in increasing the number of MSC sites on these roads and spreading the total hours of MSC operation over all sites.

Queensland MSCs are randomly scheduled to approved sites with the intention of reducing the predictability of camera placements. MSC sites are located after identifying an area with diameter of one kilometre (urban regions) or five kilometres (rural regions) with a history of speed-related or serious casualty crashes. Newstead, Budd and Cameron (2017) and Cameron, Newstead and Budd (2017) estimated the local crash effects up to 4 km from sites on rural roads during 2008-2015. During 2013 when rural MSC hours were at their peak, they found 41% reduction in fatal crashes, 30% reduction in serious casualty crashes and 27% reduction in all casualty crashes.

## Method

### *Transportability of Queensland experience to Victoria's rural MSCs*

The effects of Queensland's MSCs on rural roads could be used to estimate that at new MSC sites on Victoria's rural roads if:

- New sites had at least two serious casualty crashes within 2.5 km during a recent 5-year period
- MSC sessions are randomly scheduled to all new sites
- Each new site is visited and operated for at least 35 hours per site per year, the average intensity per site in Queensland.

### *Estimated crash effects of new rural MSC sites in Victoria*

In May 2019, the Victorian Government announced plans to increase the operational hours of MSCs by 75%. On rural highways, this should take the form of an increase in MSC sites (estimated 1079 current sites). If selected, scheduled and visited by MSCs as in Queensland, they would expect to reduce crashes over 8 km sections centred on the new sites (Cameron and Newstead 2018).

All 8 km sections of rural category A divided roads and A, B and C undivided roads in Victoria were ranked by their number of serious crashes during 2006-2015 (10 years). The 75% increase of the existing rural MSC sites (810 new sites) was distributed over the categories of rural roads in proportion to their length. The highest ranked 8 km sections within each road category were selected as potential new MSC sites near the centre of each section.

## Results

Table 1 shows the estimated savings in crashes of each severity if MSCs were randomly scheduled to operate at each of these new sites for at least 35 hours per year (e.g. 14 visits at 2.5 hours per visit). In total, the 8 km sections cover 34% of the total length of each rural road category.

**Table 1. Crash savings per year from 75% increase in new sites for randomly-scheduled mobile speed cameras on rural roads in Victoria**

Rural road type	Length (km)	Percent increase in sites*	New sites	Increase in hours per year	Fatal crashes saved per year	Serious injury crashes saved per year	Minor injury crashes saved per year
Divided A Roads	418	New site numbers distributed by road length	18	617	3.0	51.9	112.3
Undivided A Roads	2,606		110	3,848	4.0	24.6	28.1
Undivided B Roads	3,907		165	5,769	5.0	29.5	33.3
Undivided C Roads	12,252		517	18,090	10.4	65.9	75.6
<b>All Highways A-C Total</b>	<b>19,183</b>	<b>75%</b>	<b>810</b>	<b>28,324</b>	<b>22.5</b>	<b>171.9</b>	<b>249.3</b>

\* Increase from 1079 rural MSC sites operated for 48,091 hours per year during 2013

## Conclusions

The effectiveness of MSC operations on rural roads in Victoria could be increased by selecting new sites based only on serious casualty crash history within 2.5 km and randomly scheduling MSC sessions to these sites. The estimated annual savings in crashes across the road sections influenced by MSC operations at the new sites are 22.5 fatal crashes, 172 serious injury crashes and 249 minor injury crashes.

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## Active and Safe: Young children as engaged road users in their communities

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### Abstract

*Starting Out Safely* is an early childhood road safety education (RSE) program focused on children, parents, and educators working together to guide children's learning and becoming safe and independent road users. Funded by the Victorian Government, the program has been developed in collaboration with leading experts through evidence-based research and best-practice principles.

A 2019 Inquiry Project was undertaken to challenge educators to abandon views of RSE as one-off curriculum episodes and work locally with children to understand road safety issues and make positive change. Participants were encouraged to use RSE as a community engagement mechanism to enable children to realise their full potential as citizens.

The project findings will be shared with a view to motivate early childhood services to contribute to the [Towards Zero](#) initiatives. Examples showcase how RSE can be embedded into curriculum to create safer communities for everyone.

### Background

*In recent research, efforts to understand children's standpoints and treat them as knowledgeable actors in the community suggest that children come to understand citizenship in the rich and varying social and political contexts of their everyday lives. If children are positioned as partners in building safe, humane, and responsive communities and not merely as vulnerable dependents and objects of concern, they have the potential to strengthen communities* (Smith 2010, cited in Phillips, Ritchie, Dynevo & Moroney, 2019, pg 23).

For children learning about being safe starts from birth.

Learning how to undertake this important work in meaningful and innovative ways requires an ongoing process of inquiry.

If educators are to respond to the significant evidence about the vulnerability of children as road users that identifies road trauma as a leading cause of death and disabling injury, it is important they act strongly to protect children from harm.

Contemporary early childhood education invites us to leave behind a view that children are passive recipients of adults' ideas and increasingly see children as active collaborators in their own and others learning. This project updates the road safety community on the ground-breaking work (Waters et al., 2014) undertaken in Victoria that combines the evidence base of early childhood education and road safety thereby offering children the best chance at becoming safer road users. The VicRoads *Starting Out Safely* program has successfully brought together these two disciplines in a sophisticated response that results in lifelong road safety benefits. Early childhood road safety education involves children, parents, carers, early childhood educators and the community working together to guide children's road safety awareness and to support the development of practical knowledge, skills, behaviours and attitudes that increase their safety in the road environment.

Within this context, the overall aim of early childhood road safety education is to reduce the risk of serious injury and death to young children from road trauma. Since 2011 Early Learning Association Australia has delivered the Department of Transport funded *Starting Out Safely* program to early childhood educators and services across Victoria. During this time over 10,000 educators have participated in professional learning that has invited consideration of road safety education in line with the expectation and concepts of the early years practice.

### **A new approach**

This presentation outlines a new approach to professional learning for RSE that invited educators to collaborate with their colleagues in an inquiry approach to practice. Utilising an action research methodology that focused on a noticing, reflecting, planning and acting cycle, the process was designed to improve and deepen our practice.

### **Proposed plan**

The design of the project enabled educators to use an inquiry approach to reflect on a specific area of practice - in this case, road safety education - in order to extend innovation and outcomes for young children and their families. The process reflected on and developed understandings, identified possible actions and implemented changes to practice that related directly to a local road safety issue. The project was supported through professional mentoring conversations and in-service support.

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## Comparison of Skidding Vehicle Drag Factors on Various Surfaces

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Peter Redwood<sup>a</sup>, Daniel Sycz<sup>a</sup>, Lindon Walker<sup>a</sup>

<sup>a</sup>Victoria Police Forensic Services Department – Collision Reconstruction and Mechanical Investigation Unit

### Abstract

In 2018, there were 1,146 deaths on Australian roads with vehicle speed estimated to be a direct factor in 30% of all road accidents. (Bitre, 2019) Collisions are analysed to determine causation including driver behavior, speed, vehicle safety and road design. Vehicle speed analysis relies heavily on the determination of the drag factor at any collision scene. Test skids at the collision site are regarded as the most reliable method to determine drag factor. The use of published drag factor tables has been criticised as the results are not case specific. Since 2002, Victoria Police (VP) have performed over 1275 test skids on Victorian Roads. Tests have been performed on various surfaces with and without anti-lock braking (ABS) producing results consistent with published worldwide data sets. Results support the use of published data sets for speed determination when test skids cannot reasonably be conducted at the collision site.

### Background

In 1990, Northwestern University Traffic Institute (NUTI) published a table including drag factors for a variety of surfaces. Collision reconstructionists rely on tabulated data to estimate vehicle speed when test skids are not possible. The 2<sup>nd</sup> edition of the book published in 2005 did not include the table due to criticism of the reported values. Bartlett (2007) concluded that the result published by NUTI were conservative, subsequently underestimating vehicle speeds. Without reliable data, the ability to calculate vehicle speed is limited to scene attendance.

*Table 1. Skid Resistance Table Published by North Western Traffic Institute (Fricke, 1990)*

Description of Road Surface	Dry				Wet			
	< 48 km/h		> 48 km/h		< 48 km/h		> 48 km/h	
	From	To	From	To	From	To	From	To
<b>ASPHALT</b>								
<b>New</b>	0.80	1.20	0.65	1.00	0.50	0.80	0.45	0.75
<b>Travelled</b>	0.60	0.80	0.55	0.70	0.45	0.70	0.40	0.65
<b>Traffic Polished</b>	0.55	0.75	0.45	0.65	0.45	0.65	0.40	0.60
<b>Excess Bleed</b>	0.50	0.60	0.35	0.60	0.30	0.60	0.25	0.55
<b>GRAVEL</b>								
<b>Packed</b>	0.55	0.85	0.50	0.80	0.40	0.80	0.40	0.60
<b>Loose</b>	0.40	0.70	0.4	0.70	0.45	0.75	0.45	0.75

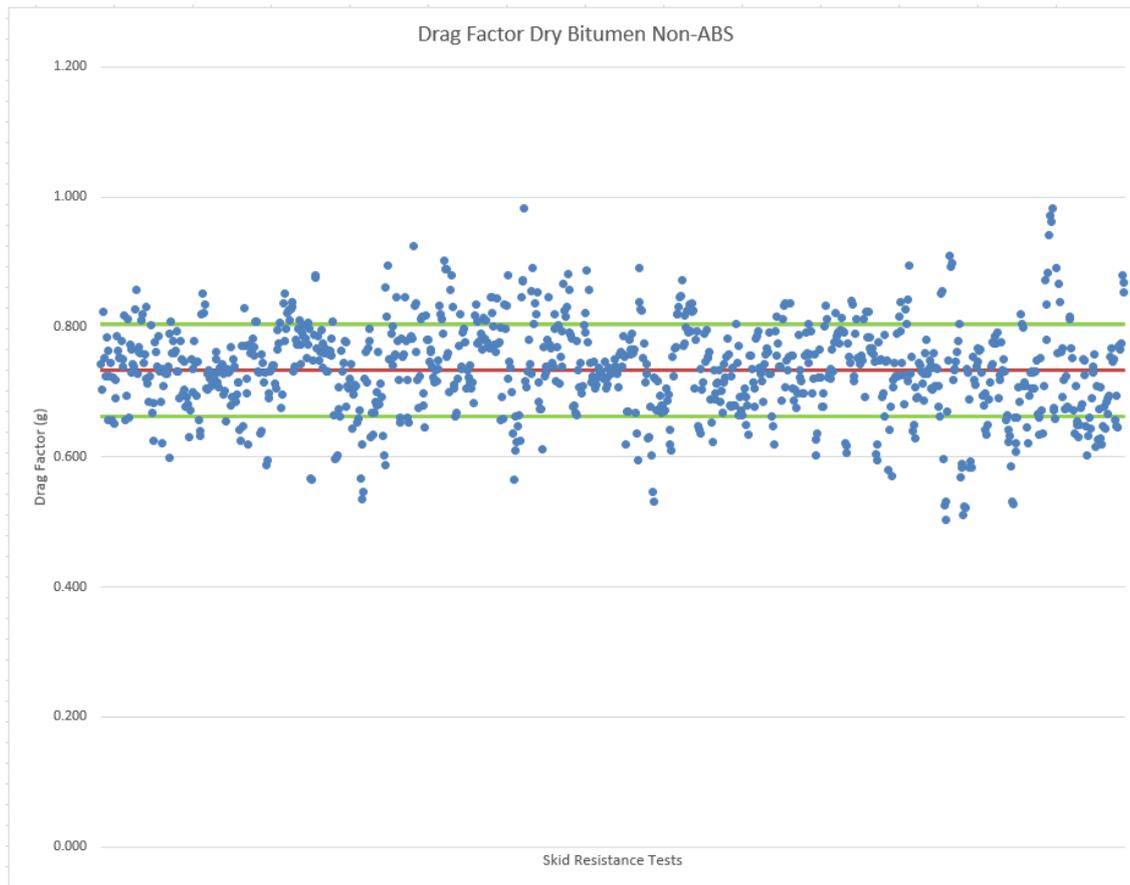
### Method

All skid resistance tests were performed by the VP Collision Reconstruction Unit (CRU) between 2002 and 2019. Tests were performed with and without ABS at accident sites throughout Victoria. Drag factor was measured using Vericom accelerometers in accordance with manufacturer specifications. Test vehicles from the VP Fleet included Holden Commodore, Ford Falcon and Volkswagen Passat. Tests speeds ranged between 45 km/h and 60 km/h.

## Results

### *Bitumen*

968 tests were performed on dry bitumen with ABS disabled. Results ranged between 0.504 and 0.983 with a mean of 0.734 (SD  $\pm 0.071$ ). 95% of all results fell within 0.592 and 0.876. Fricke (1990) reported a range of 0.55 to 0.70 and Bartlett (2007) reported a range of 0.64 to 0.88 for dry bitumen without ABS. The results reported by VP support the notion that Fricke's data will produce conservative speed estimates. More than 50% of VP results fell higher than the Fricke maximum of 0.70.



**Figure 1. Victoria Police drag factor results for travelled bitumen without ABS**

114 tests were performed on dry bitumen roads with ABS. The mean result was 0.858 (SD  $\pm 0.084$ ). 95% of results fell within 0.690 and 1.026. Typically, ABS produce results 14.5% higher than non-ABS supporting research of Bartlett and Wright (2010) which found that ABS produced results 14.2% higher than non-ABS.

### *Gravel*

86 tests were performed on gravel surfaces yielding a mean of 0.589 (SD  $\pm 0.082$ ). 95% of results fell between 0.425 and 0.753, 5% lower than the ranges published by Fricke (0.50 to 0.80) and Bartlett (0.623). The sample size on gravel with ABS (3) was too small for reliable evaluation. However, the 3 ABS gravel tests provided a mean 18% less than non-ABS tests. Bartlett (2010) found that on gravel, ABS yields results up to 20% less than non-ABS.

## ***Grass***

51 tests were conducted on grass with a mean of 0.557 (SD  $\pm$  0.09). There is limited research in skid resistance testing on grass in Australia. Results are inconsistent with NZ research which produced results of 0.21 on white clover grass. (Cenek, Jamieson and McLarin, 2000). This data set is significant having been collected locally, providing previously unavailable records.

## **Conclusions**

Collision reconstruction is pivotal in law enforcement aimed at reducing the road toll with deterrence. Without tabulated data, speed analysis is limited to evidence from scene attendance. Conditions, road surface and terrain can prevent testing even when a reconstructionist has attended. VP skid resistance tests are consistent with worldwide data sets and provide results previously limited for grass surfaces. Using data sets enables reliable speed analysis when scene attendance isn't possible.

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## **Developing a world-first Mobile Phone Detection Camera Program in NSW: from no known solution, to operational program in two years**

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<sup>a</sup>Transport for NSW, <sup>b</sup>Phaseprofessionals, <sup>c</sup>Monash University Accident Research Centre

### **Abstract**

In NSW since 2012, there have been over 182 casualty crashes involving a driver using a hand held mobile phone – resulting in at least 13 deaths and 243 injuries. The true number is likely much higher due to under reporting.

In less than two years Transport for New South Wales (TfNSW) turned an idea for tackling illegal hand held phone use while driving into a world-first road safety initiative.

Seeking a fresh approach, the NSW Government stimulated the market to develop a solution by creating the legal framework for camera detected offences using established principles from speed enforcement.

A pilot proved that the camera system could reliably detect illegal mobile phone use and informed the design of an end-to-end operating model.

The NSW Mobile Phone Detection Camera program became operational in December 2019 and is expected to save around 100 fatal and serious injury crashes over five years.

### **Background**

Research shows that the crash risk (odds ratio) associated with illegal mobile phone use while driving is 1.83 (Owens et al., 2018).

The Mobile Phone Detection Camera (MPDC) pilot was developed as part of the NSW Road Safety Plan 2021 which aims to reduce road fatalities and serious injuries by 30% by 2021 and contribute towards the aspirational target of zero road trauma by 2056.

### **Process**

A global literature scan indicated no automated mobile phone detection programs existed. In July 2018 *The Road Transport Act 2013 (NSW)* was amended to enable camera-based enforcement. An agile procurement strategy<sup>1</sup> was designed to help find a solution – ahead of technology testing and evidence based policy and funding decisions.

Following competitive procurement, Acusensus Pty Ltd was engaged to pilot MPDCs, in partnership with the NSW Government. The pilot tested both fixed and transportable cameras between January

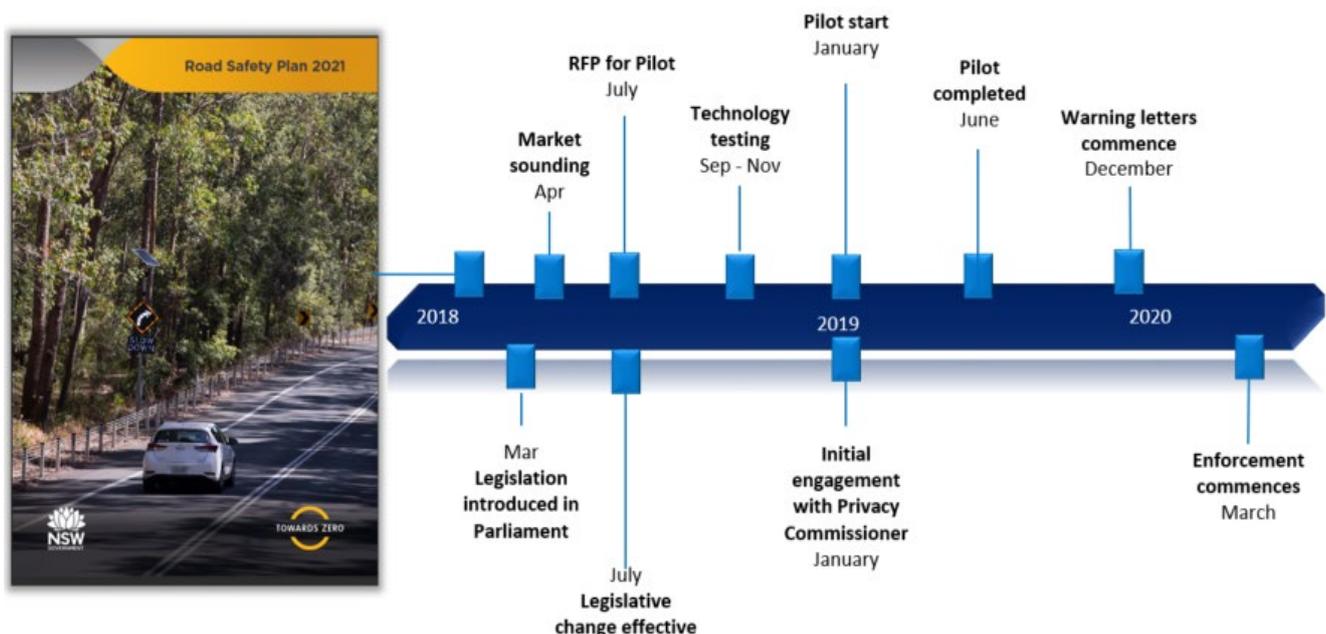
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<sup>1</sup> The procurement strategy was designed to support industry innovation by seeking competency and capability before supporting real-world testing of three possible solutions. The procurement for a Pilot was also undertaken in a way that supported direct contract negotiation (pending the Pilot being deemed a success), to enable timely rollout of the proven technology.

and June 2019. 8.5 million vehicles were checked and over 100,000 drivers (or 1.2 per cent) were detected using their mobile phone illegally (Wall et al, 2019). Artificial intelligence software identifies images most likely to display illegal mobile phone use for verification. The system proved to be highly reliable in all traffic and weather conditions. The pilot also provided an opportunity to explore security, privacy and supporting infrastructure requirements for the operational program.

Independent modeling identified the program, designed to undertake 135 million vehicle checks per year, is likely to achieve trauma savings of around 100 fatal and serious injury crashes over five years (Warner et al, 2021).

## Project Overview



*Figure 1. Project Overview Timeline*

## Rollout

The program of fixed and transportable cameras is being expanded over three years to achieve 135 million annual vehicle checks by 2022/23 (rate of 20 checks per NSW vehicle). It is anticipated around 45 cameras will be required to achieve this.

Fixed cameras are on roads with high traffic volume and transportable cameras increase the program's range, supporting 'anywhere, anytime' deterrence. This is enhanced by not signposting camera locations. Independent modeling indicates that location based signage would reduce program benefits by around 80% (Warner et al, 2021).

Instead, a comprehensive communication strategy including general network signage ensures that drivers are aware of the program. A three-month warning letter period (December 2019 – February 2020) also helped educate drivers to change their behavior before penalties were applied.

## Conclusions

The most recent survey (October 2020) shows 83% community support for MPDC enforcement.

Early indications since the program commenced in December 2019 suggest a positive shift in driver behaviour and improvement in compliance with the law. The program will be monitored and evaluated to ensure alignment with policy settings and road safety outcomes.

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## Caravan Safety Awareness Project in northern NSW

Jenny Felsch<sup>a</sup>, Penny Sutton<sup>a</sup>, Anna Attard<sup>a</sup>, Alison Ditton<sup>a</sup>, Inspector Peter McMenamin<sup>b</sup>

<sup>a</sup>Transport for NSW, <sup>b</sup>NSW Police Force

### Abstract

Caravanning is more popular than ever in Australia. There are now nearly 154,400 caravans registered in NSW with caravan registrations rising 53% in the 7 years to 2019. In NSW, over the same period, there were a total of 2,318 crashes involving caravans/ trailers, of which 19.1% were serious injury or fatal crashes.

To engage caravanners, industry associations, caravan clubs, caravan safety educators and improve caravan safety awareness in Northern Region, Transport for NSW (TfNSW) has collaborated with NSW Police Highway Patrol. TfNSW has delivered engagement activities in northern region and the Centre for Road Safety has developed a caravan safety webpage and collateral for statewide use. Other regions in NSW, also noticing caravan safety concerns, are keen to learn from our findings and implement our initiatives.

### **Background:**

Crash data was reviewed following a fatal crash involving an overloaded vehicle/van combination in Northern region. The data from July 2012 to June 2019 showed that 17.7% of all caravan/trailer crashes in NSW occurred in Northern Region.

An informal review of fatal crash police investigations identified a need to improve awareness of safe towing practices, the effects of weights & mass distribution on safety, how to weigh the car, caravan, towball weight and combination; safe distribution of load; tyre safety; safe towing speeds and fatigue management. Police also said that cleaning up debris from caravan/trailer crashes increased risk to staff attending the crash scene and decreased traffic flow.

Caravan safety tips are available on various websites, now including the TfNSW website, however, event participants said they were confused by written explanations for calculating weights and mass and their practical application. Discussions with NSW Police, caravanning educators, caravan groups and industry suggested that some caravanners could be unaware that they were overloading their vehicles/vans and that more education, awareness could encourage attitudinal change and improve safety.

### **Purpose of the Project**

To address issues identified in the review, TfNSW engagement activities were planned to highlight safety concerns and improve understanding. It was considered that presenting information on weights, mass and load distribution visually through demonstrations, workshops with practical sessions and animations/videos could help improve understanding and safety.

### **Activations:**

Three types of engagement activities were trialled. For the first event, 30 people visited a pop up caravan safety information session conducted at a Rest Area by TfNSW and NSW Police. A group of 25 people attended a caravan safety workshop with presenters from TfNSW, NSW Police, NSW Fair Trading, and National Heavy Vehicle Regulators.

Feedback from participants confirmed that caravanners did not fully understand how driver behaviour, incorrect vehicle/van weights, mass and distribution of load could affect their safety.

TfNSW Northern then delivered 3 free Caravan Safety Checking days in collaboration with Police, Councils and [Tow-Ed](#). The free caravan safety checking days were a simplified version of similar

successful [Queensland program](#) and were the first of their kind in NSW. 43 Caravanners made appointments to bring their vehicle and van to be weighed and checked by experts and were provided information on key safety issues. The majority of combinations inspected were found to have at least one compliance or safety issue which the owners were encouraged to address. Data from these events showed that the majority of combinations were being towed at the upper limits of their maximum allowable weights. Although the sample size was small, it was indicative of the recreational sector. Participants who attended the caravan safety checking days appreciated the opportunity to talk to experts, and being shown how to weigh their vehicles/vans and calculate their allowable weight limits.

**Next Steps:**

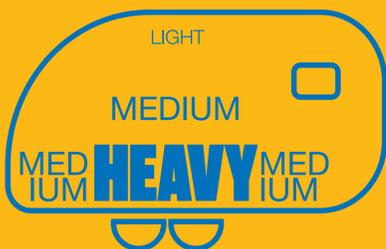
Project planning for Delivery of caravan safety awareness activities is to be shared with other TfNSW regions and key stakeholders, and could be expanded to cover safe towing practices. Consider opportunities to produce step by step instructional videos to empower caravanners to perform their own weight checks.

Some caravanners may be unaware that they are overloading their vehicles and vans or not distributing their load correctly.

SENSIBLE LOADING

Loading your caravan correctly is vital to ensure a safe trip. An incorrectly loaded caravan can lead to snaking, swaying or loss of control of your caravan and vehicle. Ensure that the heaviest items are packed low and centred over the caravan's axles and the lightest items are packed up high and distributed across the van.

THE IMAGE BELOW SHOWS HOW TO DISTRIBUTE LOAD TO IMPROVE SAFETY



PLAN YOUR JOURNEY:

Plan your trip to include plenty of breaks to ensure that you are alert, share driving with another driver, and learn to recognise the early warning signs of fatigue. You should never trust your tired self, and remember that sleep is the only cure for tiredness.

SAFE TOWING:

Driving while towing a caravan is a different experience to normal driving. It requires a higher level of knowledge and skill compared to normal driving, a need for greater stopping distances, and consideration of environmental factors such as high winds, wet roads and uneven surfaces.

Caravanning is more popular than ever in Australia. There are now nearly 154,400 caravans registered in NSW with caravan registrations rising 53% in the 7 years to 2019. In NSW, over the same period, there were a total of 2,318 crashes involving caravans/ trailers, of which 19.1% were serious injury or fatal crashes. To engage caravanners, industry associations, caravan clubs, caravan safety educators and improve caravan safety awareness in Northern Region, Transport for NSW (TfNSW) has collaborated with NSW Police Highway Patrol. TfNSW has delivered engagement activities in northern region and the Centre for Road Safety has developed a caravan safety webpage and collateral for statewide use. Other regions in NSW, also noticing caravan safety concerns, are keen to learn from our findings and implement our initiatives.



NEXT STEPS:

Project planning for delivery of caravan safety awareness activities is to be shared with other TfNSW regions and key stakeholders, and could be expanded to cover safe towing practices. Consider opportunities to produce step by step instructional videos to empower caravanners to perform their own weight checks.

# CARAVAN SAFETY AWARENESS IN NORTHERN NSW

TfNSW engagement activities were planned to highlight safety concerns. It was considered that presenting information on weights, mass and load distribution visually through demonstrations, workshops with practical sessions and animations/ videos could help improve understanding and safety.



## The attribution of casualty crashes to low-level speeding in Queensland

David Soole<sup>a</sup>, Warren Anderson<sup>a</sup>, Tracey Smith<sup>a</sup>

<sup>a</sup>Department of Transport and Main Roads, Queensland

### Abstract

The positive relationship between vehicle speeds and crash risk and severity are well understood. This paper sought to utilise speed probe data and existing crash risk estimates to determine the proportion of crashes attributable to various speeds above the posted limit on Queensland roads, with a particular focus on low-level speeding (1-10 km/h above the limit). The findings demonstrated that the majority of speeding motorists were engaged in low-level speeding. Analyses indicated that between 5.9% and 19.2% of all casualty crashes were estimated to be attributable to low-level speeding, with proportions typically higher in lower speed limit zones. Conversely, it was estimated that between 19.9% and 67.0% of speed-related crashes were attributable to low-level speeding, with proportions typically greater in higher speed limit zones. Further data analyses stratified a range of spatial and temporal variables. Policy implications of the findings are discussed.

### Background

The positive relationship between vehicle speeds and crash risk and severity are well understood (Aarts & van Schagen, 2006). However, there remains some public debate regarding the influence of low-level speeding on crash involvement. Previous research has highlighted that the majority of speeding drivers typically engage in low-level speeding exceeding the speed limit by up to 10 km/h (TMR, 2018). Therefore, determining the prevalence of low-level speeding, and the role it plays in road trauma, are essential steps in developing policy recommendations and countermeasures.

### Method

This paper utilised Global Positioning System (GPS) speed probe data<sup>1</sup> from passenger motor vehicles across the entire Queensland road network in order to determine the prevalence of speeding on the state's roads in 2018. Existing crash risk estimates developed by Kloeden and colleagues (1997, 2001), quantifying the relationship between free travelling speeds and the risk of crash involvement on urban and rural roads<sup>2</sup>, were then applied to the speed probe data to calculate population attributable risk (PAR) – the proportion of crashes estimated to result from the increase in risk associated with speeding by a specific amount, relative to the risk at the speed limit.

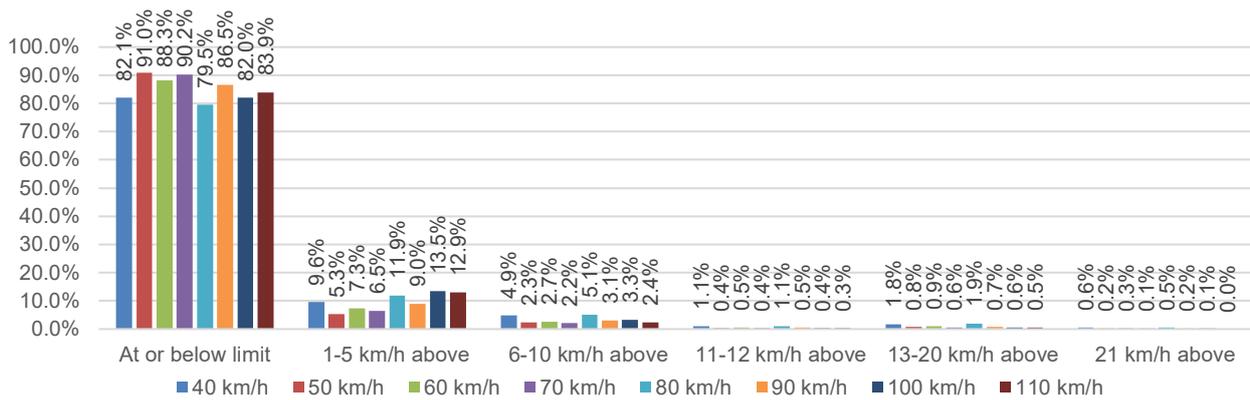
### Results

Figure 1 shows the prevalence of speeding behavior in Queensland in 2018, based on the speed probe data. As can be seen, the majority of motorists demonstrated compliant behavior across all speed limit zones (79.5% to 91.0%). Among those motorists who were speeding, between 81% and 95% were engaged in low-level speeding, with 66.2% to 84.3% travelling between 1-5 km/h over the limit. In all speed limit zones, excessive speeding (more than 20 km/h over the limit) was extremely rare.

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<sup>1</sup> GPS speed probe data involves data sourced from in-vehicle devices (such as navigation systems) that record specific data related to location, speed, time and vehicle characteristics. This licenced data is provided to the Department of Transport and Main Roads – Queensland by HERE Technologies.

<sup>2</sup> It should be noted that the original relationships between speed and crash risk estimated by Kloeden et al. (1997, 2001) were for 60 km/h urban roads and 100-110 km/h rural roads, and thus there may be some limitations associated with applying these estimates to other speed limits.



**Figure 1. Proportion of motorists travelling at various speeds, by speed limit zone, in Queensland, 2018**

Table 1 presents the proportion of all casualty crashes estimated to be associated with each speed bracket. There was a protective function associated with travelling at or below the limit, with an estimated reduction in crashes between 10.9% and 18.4% expected if all drivers travelled up to 10 km/h under the limit. The data also suggests that if all drivers currently speeding travelled at the speed limit, there would be an estimated reduction in casualty crashes of between 8.8% and 66.8%, depending on the speed limit. Excessive vehicle speeds were estimated to contribute to a high proportion of crashes, particularly given the infrequent prevalence of such behavior. That said, between 5.9% and 19.2% of *all casualty crashes* were estimated to be attributable to low-level speeding, with proportions typically higher in lower speed limit zones. Moreover, it was estimated that between 19.9% and 67.0% of all *speed-related casualty crashes* were attributable to low-level speeding, with proportions typically greater in higher speed limit zones.

**Table 1. Proportion of casualty crashes attributable to travelling at various speeds, by speed limit zone, in Queensland, 2018**

Vehicle speed (km/h)	40 km/h	50 km/h	60 km/h	70 km/h	80 km/h	90 km/h	100 km/h	110 km/h
<b>At or 1-10 under</b>	-10.9%	-15.3%	-16.0%	-18.4%	-11.8%	-14.6%	-14.7%	-16.7%
<b>Total above</b>	66.8%	39.0%	45.3%	34.9%	26.8%	18.2%	12.2%	8.8%
<b>1-5 above</b>	6.4%	3.4%	3.5%	4.1%	3.1%	3.6%	3.6%	3.4%
<b>6-10 above</b>	12.8%	6.2%	5.5%	5.9%	4.8%	4.7%	3.3%	2.5%
<b>11-12 above</b>	3.1%	2.2%	2.1%	2.2%	1.9%	1.5%	0.8%	0.5%
<b>13-20 above</b>	11.9%	10.1%	8.7%	7.8%	6.2%	3.5%	2.1%	2.0%
<b>21-30 above</b>	15.7%	11.1%	12.8%	10.0%	6.2%	2.8%	1.9%	0.2%
<b>31-40 above</b>	15.5%	4.2%	10.0%	4.6%	2.9%	1.4%	0.4%	0.1%
<b>41-50 above</b>	1.3%	1.8%	2.7%	0.3%	1.7%	0.7%	0.2%	0.1%

Further analyses revealed differences in PAR when data was stratified on spatial and temporal variables. Specifically, there was evidence of a greater proportion of crashes attributable to low-level speeding in the evening and late night/early morning, on weekends, and in more regional and remote areas.

**Conclusions**

Overall, the findings corroborated previous research showing that the majority of motorists who speed typically engage in low-level speeding. Analyses of attributable risk showed a considerable proportion of casualty crashes are associated with low-level speeding. Notwithstanding the

limitations of speed probe data, the findings suggest that policies aimed at reducing low-level speeding could have a substantial impact on improving road safety.

### **Acknowledgements**

The authors would like to acknowledge the contribution of the Monash University Accident Research Centre (MUARC), in particular Dr Steve O'Hern, Professor Max Cameron, Sujanie Peiris and Associate Professor Stuart Newstead, who were instrumental in the analysis of the data used as the basis of this paper.

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## LET'S #GOSAFELY

### A community-based multi stakeholder approach to road safety education for young adult road users

Georgia Symmons<sup>a</sup> and Peta Simpson<sup>a</sup>

<sup>a</sup>Fit to Drive Foundation

#### Abstract

Since 2014, the Fit to Drive Foundation's F2D Year 11 (F2D) Workshop, a community-based road safety intervention, has reached more than 120,000 students throughout Victoria. The F2D Program is delivered by trained youth as facilitators and ambassadors to empower young people to talk about making good decisions on the road and be safer road users. The F2D Program integrates research, program logic development and delivery and evaluation in a multi stakeholder approach to road safety education for young adult road users that is local, community-based and long term. The paper will explore the effectiveness of the F2D Program in reducing road trauma in the community. Participant feedback from students and teachers is continuously measured and insights gained evolve the program, resulting in a contemporary and positive approach to community-based road safety education for all stakeholders. This paper will share these learnings.

Fit to Drive (F2D) is a local community and school road safety educational model, targeted at young adult drivers and passengers who, despite a falling road toll, remain significantly overrepresented in road trauma in Victoria. The F2D Workshop is presented as a half-day (four hour) road safety education program, where Year 11 (senior school) students participate in small group discussion workshops peer led and facilitated by trained university students. The core principle of the F2D model, is that - *the choices young people make; make the difference*. The F2D model's strength is an evidenced-based approach to curriculum design (involving research, evidence, design, development and evaluation) supported by a network of road safety partners. The philosophy of the program incorporates the understanding that young people have the capacity to shape attitudes in relation to risky driving; and supports them to take ownership and responsibility for their own and their peers' safety. At its core, the F2D Program harnesses the promotion of community partnerships and a youth-led approach to road safety that is based on a learning by doing.

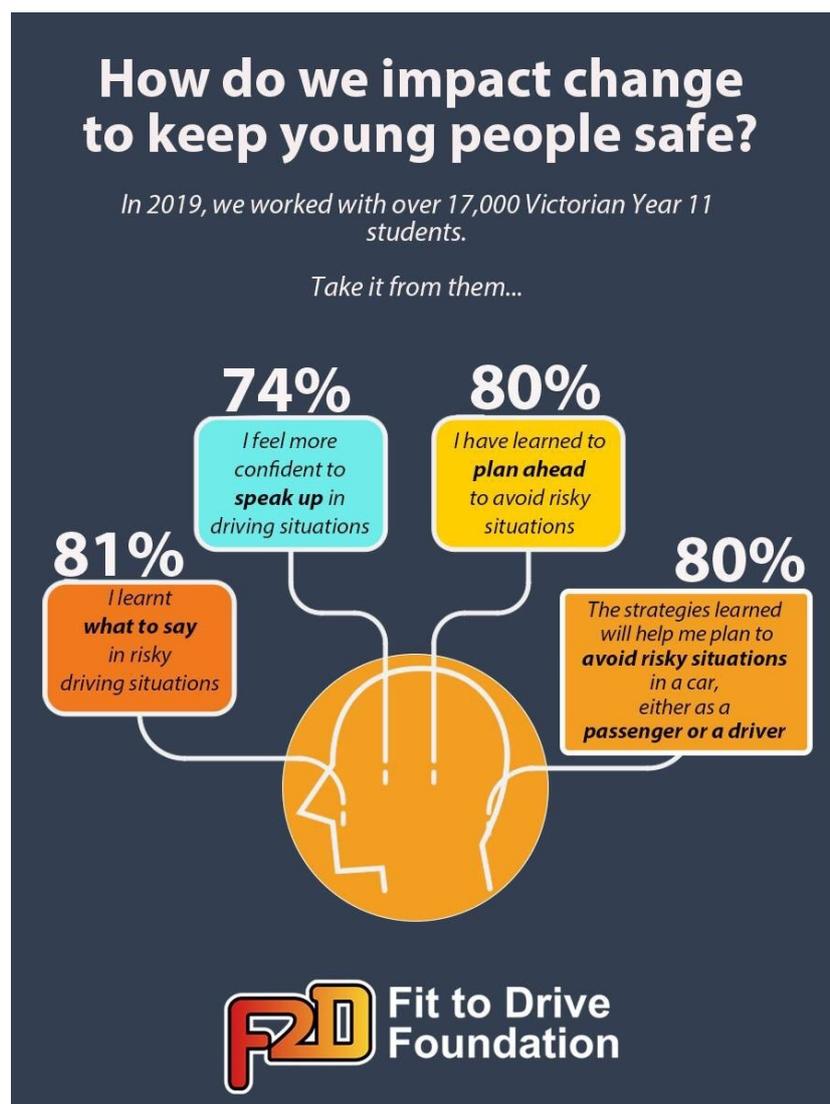
The F2D Program is part of the Victorian Government's *Towards Zero 2016-2020 Road Safety Strategy and Plan* and is funded by Transport Accident Commission (TAC), VicRoads, local councils and service organisations such as Rotary and Lions Clubs. F2D is supported by major stakeholders in road safety including Victoria Police, Department of Education and Training (DET), Metropolitan Fire Brigade (MFB), Country Fire Authority (CFA) and State Emergency Services (SES). In 2019, the half day F2D Workshop engaged with over 17,000 students from 59 Local Government Areas, 174 education providers, and has over 40 university undergraduates trained to be road safety facilitators and ambassadors.

Drawing on the Fit to Drive Foundation's twenty years' experience in developing and sustaining community partnerships to deliver road safety education in schools, the paper describes and demonstrated the key elements of successful multi stakeholder community-based partnerships in reducing road trauma. The paper will:

- present a real world, practical program for keeping young adult road users safe
- highlight the importance of a community-based multi stakeholder approach to develop a shared understanding of road safety and evidence-based prevention strategies

- explore insights from participant feedback of students and teachers including the effectiveness of developing a personal safety plan, the F2D *Go Safely Pact*
- share learnings and insights from the delivery of 1,100 workshops throughout Victoria

This paper builds upon the works of Montero and Spencer (2016) and recognises that the F2D Program model brings people from many different backgrounds together and involves them in addressing the overrepresentation of young adult drivers and passengers in road trauma. Key elements of program include involving young people presenting and talking about road safety by showing not telling; the Fit to Drive Foundation's ability to harness and extend the collaborative ability of local community networks; and also the use of positive messages to shape young adult road user behaviour. The number of students, schools, local government areas undertaking the program are a measure of its success.



**Figure 1 – 2019 Fit to Drive Impact**

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## A Structural Equation Model for Pedestrian Crashes in Sydney

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<sup>a</sup>Transport for New South Wales

### Abstract

Over the five year period between 1 January 2014 and 31 December 2018, pedestrians were killed more than any other road user in Sydney, making up around 40% of the road fatalities in Sydney, New South Wales (NSW) and the trend is consistent in every year over the five year period. In this paper a structural equation model is proposed to identify factors impacting pedestrian crash severity in Sydney. Impact of road characteristics, environmental factors, driver characteristics, and pedestrian characteristics were analysed to identify their impact on crash severity. Numerous iterations were conducted to achieve statistically significant and a good-fit model. Using this, countermeasures were proposed to address these crashes, particularly fatal and serious injury crashes, across the Safe System pillars.

### Background

There was a total of 82,208 crashes in Sydney between 1 January 2014 and 31 December 2018 and of these, around 8% involved a pedestrian. However, pedestrians were killed more than any other road user (around 40%), making up the most vulnerable customer group. Understanding the factors behind these crashes can help in determining the most appropriate initiatives to reduce road trauma.

Linear regression models have been used traditionally to identify factors influencing crashes (Wright & Burnham 1985). In order to improve the model forecasting, Negative Binomial regression models were considered suitable (Saccomanno & Buyco 1988; Miaou & Harry 1993) and interest in the Empirical Bayesian approach to crash data analysis has increased significantly (Hauer 2002; Saccomanno et al. 2007). More recently, Structural Equation Modelling (SEM) technique is becoming popular among road safety researchers and practitioners to identify factors influencing traffic crashes because of its multivariate nature (Wang & Qin, 2014; Schorr & Hamdar, 2014; Kim, Pant, & Yamashita, 2011; Eboli & Mazzulla, 2007). SEM uses a combination of regression, factor analysis and analysis of variance in order to estimate interrelated dependence relationships simultaneously.

### Method

The data analysed relate to 6,510 pedestrian crashes that occurred in Sydney between 1 January 2014 and 31 December 2018. The data was extracted from Crashlink, the road crash database owned and administered by Transport for NSW.

In the proposed structural equation model the observed variables are the crash characteristics described in Table 1, and the indicator variables are crash severity, number of persons killed, number of persons injured and number of vehicles involved in the crash. The latent variables are the unobserved road crash aspects that can be explained by the observed variables.

A statistical-descriptive analysis of the crash characteristics was carried out. The structural equation model was developed and calibrated by using Stata version 13. Numerous goodness-of-fit statistics showed satisfactory results, and these are: Chi-Square, Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA).

Countermeasures were proposed from the analysed results to address pedestrian crashes, specially fatal and serious injury pedestrian crashes.

**Table 1. Crash characteristics considered in the model**

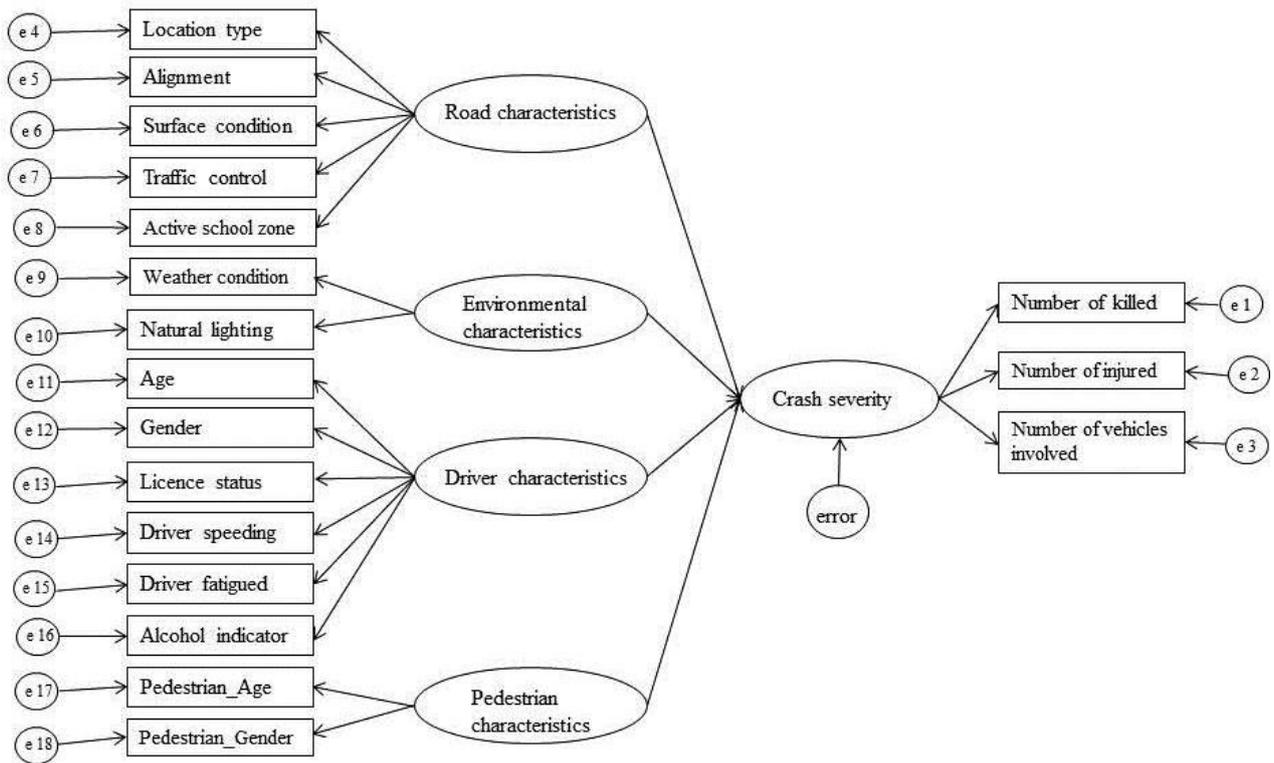
Latent variable	Observed variable	Level of variation
<b>Road characteristics</b>	Location type	Intersection, 1-way street, 2-way undivided, Divided road, Single limited access, Dual freeway, Other
	Alignment	Straight, Curved, Unknown / not stated
	Surface condition	Dry, Wet, Snow or ice, Unknown / not stated
	Traffic control	Signal controlled, Pedestrian crossing, Stop sign, Give way sign, No right/left turn, No U turn, Road / railway worker, No traffic controls
	Active school zone	Yes, No, Not a school zone
<b>Environmental characteristics</b>	Weather condition	Fine, Raining, Overcast, Fog or mist, Snowing or sleeting, Other (e.g. hail), Unknown / not stated
	Natural lighting	Daylight, Dawn, Dusk, Darkmess, Unknown/ not stated
<b>Driver characteristics</b>	Age	<20 years, 20 – 40 years, 40 – 60 years, >60 years
	Gender	Female, Male
	Licence status	Standard, Provisional, Learner, Unauthorised, Unknown
	Driver speeding	Yes, No
	Driver fatigued	Yes, No
	Alcohol indicator	Legal, Illegal, Unknown
<b>Pedestrian characteristics</b>	Age	<20 years, 20 – 40 years, 40 – 60 years, >60 years
	Gender	Female, Male

## Results / Discussion

Figure 1 presents the structural equation model for pedestrian crashes in Sydney. Model results were statistically significant and showed that the “Location Type” observed variable has the greatest effect through the “Road characteristics” latent variable on crash severity; while, through the “Driver characteristics” latent variable, “Gender” variable has the greatest effect. For “Pedestrian Characteristics” latent variable, “>60 years” variable has the greatest effect. The proposed model can be useful in order to analyse the correlation between crash characteristics and identify the attributes which influence the severity of road crashes.

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**Figure 1. Structural equation model for pedestrian crashes**

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## **Effectiveness of drink driving countermeasures in Australia: a national policy framework**

Greer Banyer<sup>a</sup>, Eric Howard<sup>b</sup>, Anne Harris<sup>c</sup>, Claire Murdoch<sup>a</sup>, Ruth Graham<sup>a</sup> & Louise Higgins-Whitton<sup>a</sup>

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### **Abstract**

Drink driving is a persistent problem and remains one of the leading causes of death and trauma on Australian roads. This project collates statistics of alcohol-related trauma over a three year period (2015-2017) across Australian jurisdictions, and reports the differing legislation, penalty and enforcement practices across Australia. By building a picture of the trauma and understanding the different starting points of each jurisdiction, this Austroads project delivers a national policy framework that brings together current and potential countermeasures to reduce this trauma and work towards eliminating drink driving deaths and serious injuries. A staged approach to the implementation of evidence-based solutions is offered for use by different jurisdictions as appropriate. Strong empirical evidence is provided for countermeasures including for lowering the legal BAC limit for all drivers, improved deterrence through highly visible and randomised enforcement and working more closely with alcohol and other drug sectors to manage alcohol dependent drivers.

### **Background**

Drink driving in Australia remains a significant road safety problem, resulting in over 200 deaths and thousands of serious injuries nation-wide each year. All Australian jurisdictions have adopted a Towards Zero approach to road safety and changes will be needed to address drink driving if the goal of zero lives lost on our roads is to be achieved. This is an Austroads project that was sponsored and project managed by Transport for NSW. It involved collaboration and input from all Australian jurisdictions with the overall aim of developing a best practice Australian policy and regulatory framework to encourage effective reform that reduces and prevents drink driving and riding trauma.

### **Method**

The development of the framework involved a literature review and extensive consultation with all Australian road agencies and related departments in order to understand the current policies in Australia. Acknowledging that individual jurisdictions may be at different stages in terms of implementing drink driving policies, a staged approach was taken to developing a national framework that involved different levels of practices based on implementation of various evidence-based solutions.

### **Findings**

The framework validates some current policy and practice and challenges others and provides suggestions for the most effective countermeasures that jurisdictions could implement in the short and long term. These include:

- extending a lower legal BAC limit to more drivers
- improving general deterrence through more highly visible and randomised enforcement, combined with covert operations
- expanding the use of interlock programs, with improved monitoring and case management

- working more closely with the alcohol and other drug sectors to manage alcohol dependent drivers
- supporting measures to reduce societal use of alcohol
- fast-tracking vehicle based systems to prevent alcohol impaired driving.

The current policies and regulations that are in place across Australia reveal areas of good practice across a number of jurisdictions. No one jurisdiction has all of the measures that create what has been defined as a “complete good practice framework”. However, given that all measures exist currently in one or more jurisdiction, these are regarded as measures that could be implemented nationally in the short-term to address drink driving.

Beyond these short-term measures, the goal of eliminating drink driving deaths and serious injuries will require far more effective and innovative measures. A number of these have been identified and are referred to as “Towards Zero” measures. These are policies and regulations that all jurisdictions should start working towards and though likely to be highly effective, will not necessarily be easy to achieve.

It is recognised that while the recommendations presented here for a national policy and regulatory framework are based on evidence, each jurisdiction starts from a different point. Many jurisdictions are currently working on implementing improvements through wider road safety policies. Consequently, assessing good practice along with the needs and priorities of each community should be considered when implementing any new measures. In addition, measures that specifically address the needs of recidivist offenders, people living in rural and remote communities, as well as indigenous and CALD communities are likely to require different approaches.

# BikeSpot 2020 – Crowd mapping cycling stress across Victoria

Anthony Aisenberg

## Abstract

Concerns about safety and crash risk, both real and perceived, are the most important determinants of whether people cycle. Cycling stress (particularly in traffic) is instrumental in influencing the choice to ride. If a single section of a route is perceived to be highly stressful, many people, particularly new riders, will likely decide not to ride. BikeSpot 2020, a collaboration between CrowdSpot and the Amy Gillet Foundation, is a project that maps the safety concerns and level of cycling stress experienced by cyclists across Victoria. Outcomes from this project will help inform partnering local and state government agencies on specific locations that have relatively high level of traffic stress and how to maximise the return on the investment into infrastructure for safe cycling.

## Background

BikeSpot 2020 is an extension of the original 2016 BikeSpot project that successfully crowdsourced over 2,500 data points of perceived safe and unsafe cycling locations across Metropolitan Melbourne. Funded largely through a TAC Community Road Safety Grant and partnering with 13 Government organisations, a major focus of the original BikeSpot project was also to gain insights into comparing the top unsafe locations with historical crash locations. Whilst some of these findings may be shared at the conference, the focus of this presentation will be on comparing the 2016 and 2020 results and furthering our understanding of cycling stress from the latest 2020 dataset.

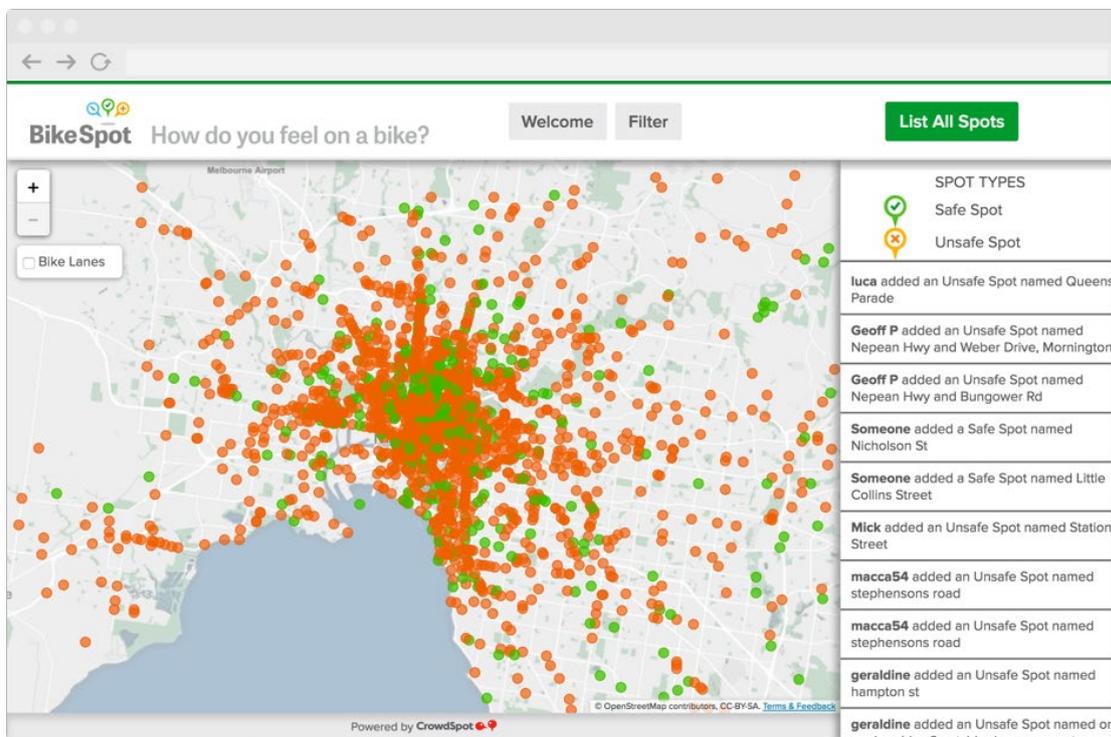


Figure 1. Screenshot of BikeSpot 2016

## Description and Purpose of the Project

The primary objective of this project is to create a crowdsourced spatial dataset of locations in Victoria where cyclists experience cycling stress. This map will help to inform priorities for cycling infrastructure improvements across all Victorian roads. Internationally, cities that have invested in connected and fully protected cycling corridors have recorded the biggest safety improvements and boosts to cycling participation.

This data collection activity will take place between late March 2020 and late May 2020 and help to ensure that investment in cycling infrastructure is prioritised to target the biggest barriers in the network.

## Deliverables and Outcomes of the Project

The deliverables of this project include:

- An online interactive map for cyclists to share their level of traffic stress
- A spatial dataset of cycling traffic stress
- A visualised map of cycling traffic stress
- A deeper understanding of the types of issues that cause cycling stress
- An understanding if locations received both safe and unsafe submissions
- Comparison of top 2016 and 2020 unsafe and safe locations (see table below)
- Evaluation on the usefulness of the project dataset for government decision making

2016 Vs 2020 Top Unsafe Spots (pg 35 of BikeSpot 2020 report)

No.	Location	Unsafe category	Change
1	Southbank/Yarra Promenade	Unsafe shared path	- 6 ↓
2	Haymarket Roundabout	Unsafe bike lane	- 4 ↓
3	Swanton St / Flinders St	Unsafe bike lane	- 200 ↓
4	St Kilda Rd / Southbank Blvd	Dangerous Intersection	- 97 ↓
5	Chapel St	Narrow / Car dooring risk	+ 4 ↑
6	Sydney Rd	Narrow / Car dooring risk	- -
7	Swanston St	Mixed use zone	- 20 ↓
8	Elizabeth St (Queensberry St / Victoria St)	Unsafe bike lane	N/A*
9	St Kilda Rd / Commercial Rd	Dangerous Intersection	= 19 ↓
10	Harbour Esplanade	Dangerous speed bumps	= 5 ↓

Outcomes of the project include:

- Strong collaboration with government organisations (both Local and State) and community groups
- The Department of Transport is currently undertaking the project identifying cycling stress to inform cycling infrastructure investment. BikeSpot 2020 intends to serve as a complimentary and useful community validation dataset to compare actual and perceived stress against the Departments forecasted and predicted stress.
- Community education on what traffic stress and its impact on cycling participation
- Improved government data driven decision making based on community traffic stress locations

## Using relative risk of different travel options as part of journey planning attributes – case study from Victoria-Australia

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### Abstract

Demand for journey planning systems that generate different options is increasing to help people get to places more efficiently by providing information on time, cost and emissions that aim to ease congestion and encourage more sustainable travel. The aim of this study was to add travel risk as an element into encouraging safer travel behaviour in addition to the other attributes. By using injury and travel data in the Australian state of Victoria between 2012 and 2016, this study estimated the fatal and serious injury (FSI) rates per travel distance across nine travel modes. These rates were then applied to a real-world case to illustrate how safety can also be calculated in the form of relative risk between different available options as part of the modal choice process.

### Background

Despite the great social and economic benefits of mobility, there are associated costs with these factors. The cost of travel is represented mainly by money and time as discussed in Bates (2000) to describe modal choice attitudes. One tool that can assist in quantifying these factors is the use of journey planning systems in generating travel options from available travel modes with estimated journey time and costs. However, there can be negative consequences of travel such as injuries, pollution and noise that also have cost implications on individual and public health. The focus of this study was on fatal and serious injury which, although accepted as the major negative impacts of travel, play a role that is not yet fully acknowledged in the journey selection process. If safety becomes part of people's thinking when planning for their travel, it might influence their choice of travel mode and help reduce their exposure to higher risk options. Beirão and Cabral (2007) argued that safety is intangible and difficult to measure, although one approach could be to estimate relative risk between available travel options to illustrate the least risky option.

### Method

Serious injury data from the VicRoads crash statistics system "Crash Stats" (2012 to 2016) was available for road-related injuries to car drivers and passengers, taxi passengers, motorcyclists, bicyclists and pedestrians. Using data supplied by Transport Safety Victoria (TSV) for public transport related injuries to train, tram and bus passengers, and Victorian Integrated Survey of Travel and Activity (VISTA) 2012-2016 for travel data, fatal and serious injury (FSI) rates for the Australian state of Victoria per travel distance were calculated. These provided relative risk estimates of general risk when using multi-modal travel options for use in illustrating how FSI risk for different options can be part of other attributes in travel planning process.

### Results

Table 1 shows the FSI risk rates across the nine travel modes under study. Table 2 shows relative risk for different travel options with reference to the least risky option for a journey between the Melbourne CBD to Monash University Clayton Bus Loop. Other attribute values of travel time, cost and CO<sub>2</sub> were obtained and calculated from Google Maps, the Arevo application, Department of Transport and Main Roads (2020) and Jared (2019).

**Table 1. Annual average FSI risk rates across nine travel modes (Victoria, 2012-2016)**

Travel mode	FSI rate per 100 million km	
	Rate	95% CI
Car driver	7.7	7.3-8.0
Car passenger	5.7	5.3-6.1
Taxi passenger	6.4	3.4-11.1
Motorcyclist	602.1	564.8-641.2
Pedestrian	44.4	40.8-48.2
Cyclist	97.8	88.8-107.4
Bus passenger	3.8	2.7-5.2
Tram passenger	7.3	4.9-10.7
Train passenger	0.3	0.1-0.5

**Table 2. Real-world example of travel options for a journey between the Melbourne CBD to Monash University Clayton Bus Loop.**

Attribute	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
	Attribute value					
Car driver (km)			22.0			
Taxi passenger (km)						22.0
Motorcyclist (km)				22.0		
Pedestrian (km)	1.0	0.3				
Cyclist (km)					21.7	
Bus passenger (km)	2.7	5.0				
Tram passenger (km)		14.0				
Train passenger (km)	16.7					
<b>Total distance (km)</b>	20.4	19.3	22.0	22.0	21.7	22.0
<b>Time (min)</b>	46.0	80.0	39.0	32.0	77.0	39.0
<b>Cost (\$)</b>	5.0	3.0	12.0	6.0	0.12	45.0
<b>CO<sub>2</sub> (kg)</b>	1.3	1.6	3.0	1.7	0.0	5.1
<b>Relative risk</b>	1.0	2.3	2.8	223.1	35.7	2.4

## Conclusions

The results of this study quantified FSI risk rates based on travel distance between nine modes of travel in Victoria for use in estimating the relative risk of different journey options and the safest option. This information could be presented to travellers in addition to other attributes (i.e., time, cost, etc.) that are currently used by smartphone travel applications that influence traveller's choices and potentially encourage safer travel.

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# Using Relative Risk as Part of Journey Planning

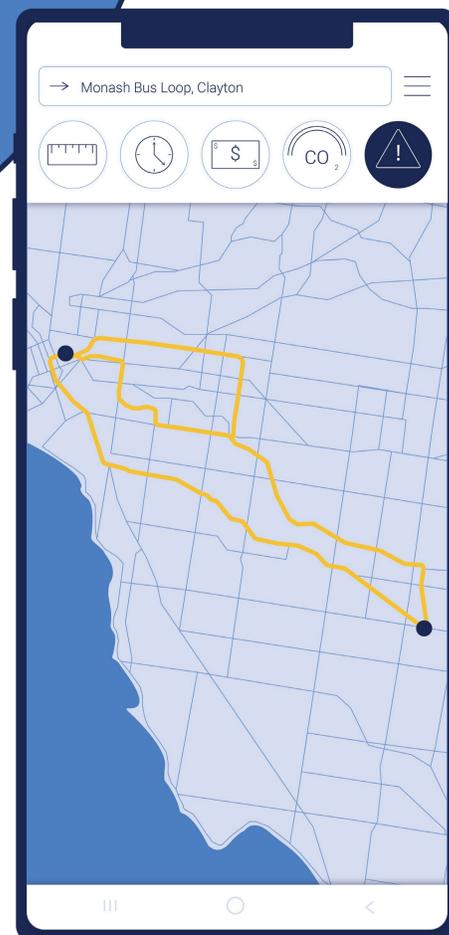
Modal shift and mode of travel have considerable ability to improve safety and achieve the 50 per cent reduction strategy by 2020.

Working towards a reduction  
**50%**

3 GOOD HEALTH AND WELL-BEING



Journey Planning Elements



MOHAMMAD IBRAHIM ET AL.

Demand for **journey planning systems** that generate different options is increasing to help people get to places more efficiently by providing information on time, cost and emissions that aim to ease congestion and encourage more sustainable travel. The **aim** of this study was to **add travel risk** as an element into **encouraging safer travel behaviour** in addition to the other attributes. By using injury and travel data in the Australian state of Victoria between 2012 and 2016, this study **estimated the fatal and serious injury (FSI) rates per travel distance across nine travel modes**. These rates were then applied to a real-world case to illustrate how safety can also be calculated in the form of relative risk between different available options as part of the modal choice process.

## BACKGROUND

The focus of this study was on fatal and serious injury which, although accepted as the major negative impacts of travel, play a role that is not yet fully acknowledged in the journey selection process. If safety becomes part of people's thinking when planning for their travel, it might influence their choice of travel mode and help reduce their exposure to higher risk options. Beirão and Cabral (2007) argued that safety is intangible and difficult to measure, although one approach

## CONCLUSION

The results of this study quantified FSI risk rates based on travel distance between nine modes of travel in Victoria for use in estimating the relative risk of different journey options and the safest option. This information could be presented to travellers in addition to other attributes (i.e., time, cost, etc.) that are currently used by smartphone travel applications that influence traveller's choices and potentially encourage safer travel. could be to estimate relative risk between available travel options to illustrate the least risky option.



MONASH University

ACCIDENT RESEARCH CENTRE

## Towards Linking Climate Phenomena to Road Safety Outcome

John Gaffney<sup>a</sup>, Elizabeth Hovenden<sup>a</sup>

<sup>a</sup>Department of Transport, State Government of Victoria

### Abstract

Climate and its many weather manifestations can explain the significant variations in Victoria's annual road fatalities. This paper illustrates how climate phenomena and weather metrics can increase crash risk, identifies the need for intervention during certain weather events and provides pathways for further research.

There is a linkage between fatalities and key meteorological climate drivers (macro-metrics) and their daily weather manifestations (micro-metrics). The key climate drivers for Victoria and south eastern Australia produce complex interactions forming long-term weather patterns influencing the occurrence of fatal crashes. Analysis of Victorian crash records has found that weather is a significant factor involved at least 10% of fatalities.

Understanding how climate influences crash occurrence can provide an understanding of the variations seen in fatalities over the past 30 years. Research in this area can be used to develop appropriate strategies to improve road safety and help reach the target of zero deaths.

### Background, Discussion and Conclusion

Overseas research has highlighted the influence of climate on crashes. Researchers have found that the physical properties conducive to road crashes occur when roads are damp (e.g. dew) and at the hot and cold extremes where hot and melting pavements (Bullas, 2007; Bullas & Hounsell, 2008; Anupam et al., 2014) and cold (and often damp) pavements increase braking distance markedly (Srirangam, 2015).

Analysis of Victorian crash records has found that weather is a significant factor involved in at least 10% of the fatalities. This is likely to be an underestimate as many influencing weather and temporal conditions are not systematically captured. Many weather events are temporal (short lived) and subtle (e.g. dew, wind), and can often be missed in crash reports. Crash records show that in hotter weather fatalities skew significantly towards the afternoon periods when pavements are hottest. In these periods, unstable vehicles such as trucks, buses, utilities, large four-wheel drives and motorcycles are over-involved (>70%) in fatalities.

The 2019 (preliminary) fatality figure of 268 in Victoria was consistent with the long-term trend whereas the lower number (213) in 2018 (outlier year) can be explained substantially by a climate anomaly year (dry and warm). As a corollary 2016, with a high number of road deaths, was a very wet year across Victoria. Annual and monthly climate and weather patterns can be orientated more towards north-south across Victoria and at other times more towards east, central or west of the state. How these patterns align with the road network and the seasonal variability of travel demand will provide keys to further understand variability in fatalities. The key climate drivers for Victoria and south eastern Australia are the Southern Oscillation Index, the Indian Ocean Dipole and the Southern Annular Mode, collectively producing complex interactions that form long-term (15-30 year) weather patterns which mix in positive or negative ways to influence the number of fatalities particularly annually.

Weather manifestations occur over much longer time horizons as well as year to year, month to month, day to day and hour to hour and contribute to many fatalities. These weather manifestations

include rain, drizzle, thunderstorms, mist, fog, lightning, hail, sleet, snow, blizzards, floods, hot, dry, ice, haze, frost, dew, wind, cloud, smog, dust storms and smoke from bushfires etc. which can result in temporal conditions often not recorded. This knowledge can be used to explain and provide understanding some of the larger annual and monthly fatality variations seen over the past 30 years.

It is probable that weather (micro) metrics such as chronological variations in temperature, humidity, dewpoint and wind speed, will be more useful to understanding crash risk than rainfall and temperature alone. The former can catch drivers by surprise, fatigue drivers faster, influence visibility, create slippery roads and create inclement conditions that result in increased crash risk which is often not evident to the motorist. Crashes come as a complete surprise, with significantly longer reaction times and stopping distances.

This research can be used to develop appropriate strategies which include technology options, vehicle safety testing, infrastructure options and driver awareness. Drivers need to be made aware that under certain inclement and other high-risk conditions, such as when dew is present or in very hot weather, they need to “wipe off” 10km/h and take more breaks in hotter weather (especially relevant for motorcyclists). The crash data indicates this is particularly important in areas of Victoria near the Great Dividing Range.

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# The acceptance of Autonomous Emergency Braking System for Motorcycles: results before and after testing

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## Abstract

Autonomous Emergency Braking (AEB) is a promising technology in the future of motorcycle safety, since it could be effective in reducing the consequences of crashes. To evaluate whether a personal experience of the intervention may influence the acceptance of such a system, an analysis of the results of a field study conducted in realistic pre-crash manoeuvres and involving 31 participants was carried out. Among users who applied for volunteering in field tests with motorcycle safety systems, the pre-test acceptability of AEB was generally lower compared to that of safety system already installed on standard vehicles. After field-testing automatic braking interventions, the participants' opinion about the potential effectiveness and reliability of the system was more positive; none of the participants considered the system damaging anymore. Field testing motorcycle autonomous emergency braking in realistic pre-crash manoeuvres turned out to have a positive influence on the acceptability of the system among our participants.

## Background

Autonomous Emergency Braking (AEB) automatically applies a braking force to reduce impact speed or prevent crashes. Previous studies showed that AEB for motorcycles (MAEB), could be effective in reducing serious consequences of powered-two-wheeler (PTW) crashes (Savino et al., 2020). Even if AEB systems are widely considered effective for passenger cars by researchers and designers, they may be reluctantly accepted by PTWs' end-users. This is because riders tend to dislike automated systems that interfere with the riding task (Beanland et al., 2013). We hypothesised that a direct experience of MAEB intervention and the linked feeling that the vehicle is still under rider control, may positively influence MAEB acceptability among end-users.

The goal of this paper is to evaluate the influence on acceptability among end-users of field testing MAEB interventions.

## Method

Field tests were carried out involving 31 participants selected among a sample of 115 subjects who volunteered for the test: they were selected to obtain a heterogeneous sample in terms of age, gender, riding experience, type of PTW user, and attitude towards rider assistance systems. Tests were performed with a motorcycle provided with an automatic braking system triggered via remote control (Lucci et al., 2020). The participants were instructed to ride along a track including a set of manoeuvres (straight path, lane change, slalom simulating traffic filtering, curves) (Lucci et al., 2021). Undeclared interventions of MAEB were deployed by the investigators at predefined locations, with nominal speeds of 35-50 km/h. Nominal decelerations of 3 and 5 m/s<sup>2</sup> were adopted, where the latter is currently considered a limit for a safe intervention (Merkel et al., 2018; Savino et al., 2016). Questionnaires were administered before and after testing MAEB; an adjusted Cooper-Harper rating scale was adopted (Cooper & Harper, 1969) to rate vehicle controllability during MAEB interventions. This scale allowed a subjective assessment of the vehicle behaviour through the effort required to maintain the desired trajectory when the vehicle stability was perturbed by MAEB intervention (the CH scale ranges from one -very easy to control-, to ten -impossible to control-).

## Results

When asked about 11 advanced assistance systems for PTW (e.g. ABS, Traction Control(TC), Active Cruise Control(ACC), MAEB, etc.), the sample end-users generally expressed a good opinion (Figure 1a) on the assistance systems; those which are already available on production PTWs (ABS, TC) were generally better rated. MAEB was considered as the least effective system: 12.8% of participants indicated it as damaging. A considerable percentage of the sample end-users were completely unaware of some safety systems (ABS-10.1%, TC-7.3%, ACC-24.8%, MAEB-22.9%).

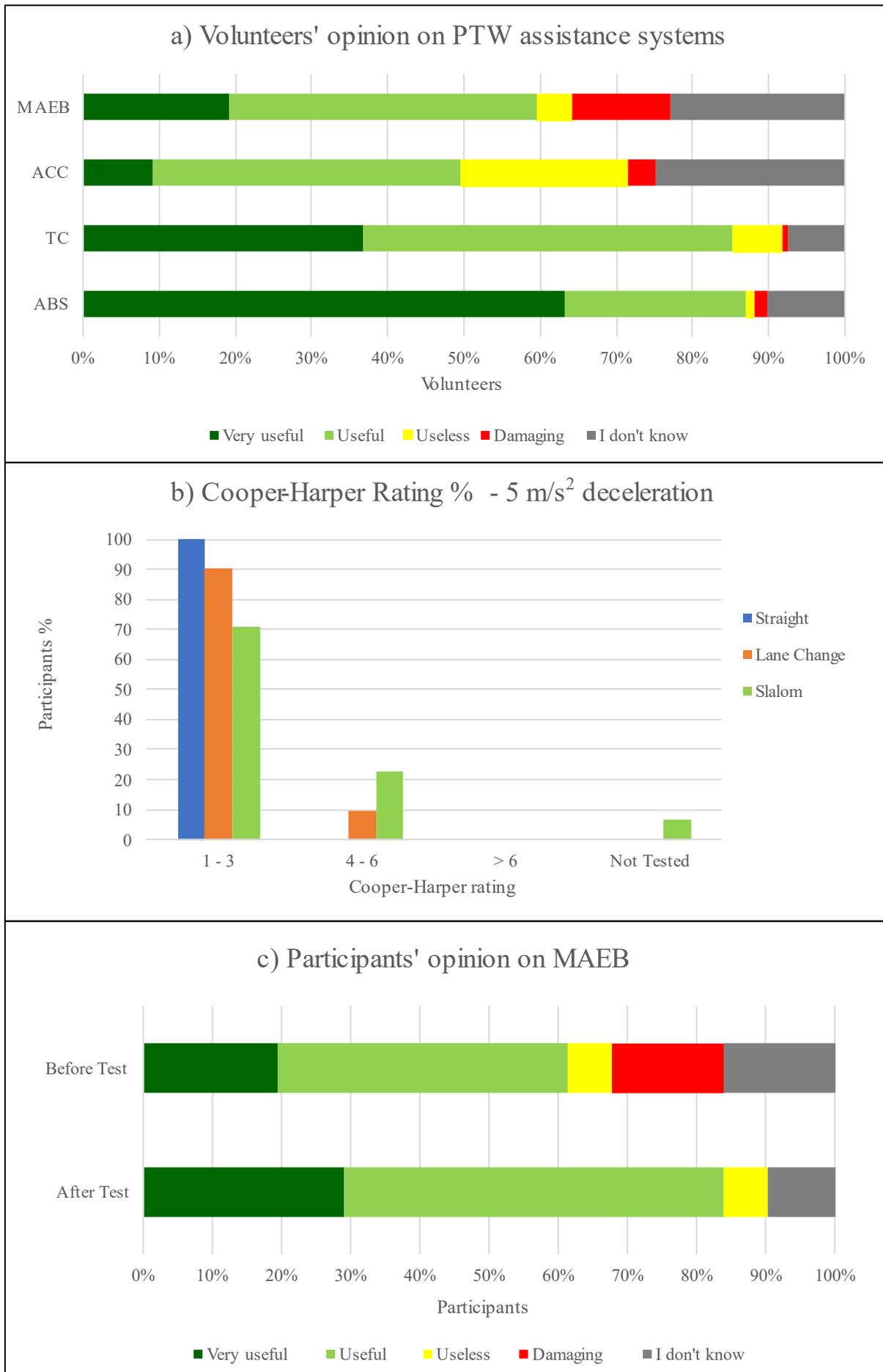
Considering the 31 participants who field-tested MAEB, the intervention turn out to be easily manageable on straight line (Cooper-Harper rating  $5\text{m/s}^2$  deceleration: <4 100%, 4-6 0%, >6 0%); lateral manoeuvres required a higher effort to control the vehicle but the intervention was still considered manageable (Cooper-harper rating  $5\text{m/s}^2$  deceleration: Lane change: <4 90%, 4-6 10%, >6 0%; Slalom: <4 71%, 4-6 23%, >6 0%) (see Figure 1c). The opinion regarding the system improved after testing the intervention: about 85% of the participants stated that MAEB is useful/very-useful and nobody considered it damaging (Figure 1b).

## Conclusions

This paper shows that field testing MAEB in realistic pre-crash manoeuvres and with realistic working parameters has a positive effect on the participants' opinion about the system. This is expected to have a positive influence on users' acceptability of the system and on willingness to have it installed on their vehicles.

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**Figure 1. Questionnaires and tests results**

## **Impact of a Rural Intersection Active Warning System (RIAWS) on Driver Speed: A Driving Simulator Study**

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### **Abstract**

Rural Intersection Active Warning Systems (RIAWS) are an innovative road safety treatment designed to slow traffic on major approaches to a high-risk rural intersection when vehicles are turning or crossing into or out of the side roads, thus reducing fatal and serious casualties. A 2x2 experimental driving simulation study was undertaken which aimed to determine the impact of signage (RIAWS versus traditional painted) and sign content (80km/h versus slow down) on drivers' instantaneous speed at rural intersections. The RIAWS "80km/h" sign resulted in significantly lower instantaneous speeds than all other types of signs including RIAWS "slow down" signs ( $p < 0.001$ ), traditional painted "80km/h" signs ( $p < .05$ ) and traditional painted "slow down" signs ( $p < .01$ ). Overall, the study found that RIAWS "80km/h" sign and not the RIAWS "slow down" sign provided the most effective option for reducing driver speeds on approach to rural intersections.

### **Background**

Rural intersections in Western Australia (WA) are frequently located on high speed roads and tend to have a higher risk of collisions resulting in serious injury or death compared to roundabouts or signalised intersections (Chow 2016). Roundabouts and signalised intersections are uncommon throughout the WA rural road network due to lower traffic volumes, maintenance required and perceived disruption to traffic flow (U.S. Department of Transportation 2015).

Rural Intersection Active Warning System (RIAWS) have been implemented in New Zealand and have shown positive road safety outcomes (Mackie et al. 2015). The RIAWS is designed to detect the presence of a vehicle approaching from a side road and/or right turning vehicles from the main through road, and sends real-time information about such events to the local control system. It represents a basic type of smart intersection warning system which is relatively low-cost to install and run. Such a system is particularly suited to the WA context due to the vast expanse of high-speed, low-volume rural roads with simple intersections which do not qualify for expensive infrastructure-based treatments such as roundabouts. RIAWS-style systems have shown to be particularly effective on these types of roads (Mackie et al. 2017) as well as on roads with poor sight distances or curved roads (Himes et al. 2016).

The aim of the current study was to determine the effectiveness of a RIAWS system in a typical WA high speed rural road environment using a driving simulator.

### **Method**

A 2x2 experimental driving simulator study was undertaken to manipulate and compare speed signage (painted traditional versus RIAWS) and speed sign content (80km/h versus slow down) at rural intersections. The different signed intersections included;

- RIAWS "80km/h" signed intersections
- RIAWS "slow down" signed intersections
- Traditional painted "80km/h" signed intersections

- Traditional painted “slow down” signed intersections
- Control intersection with no speed signage.



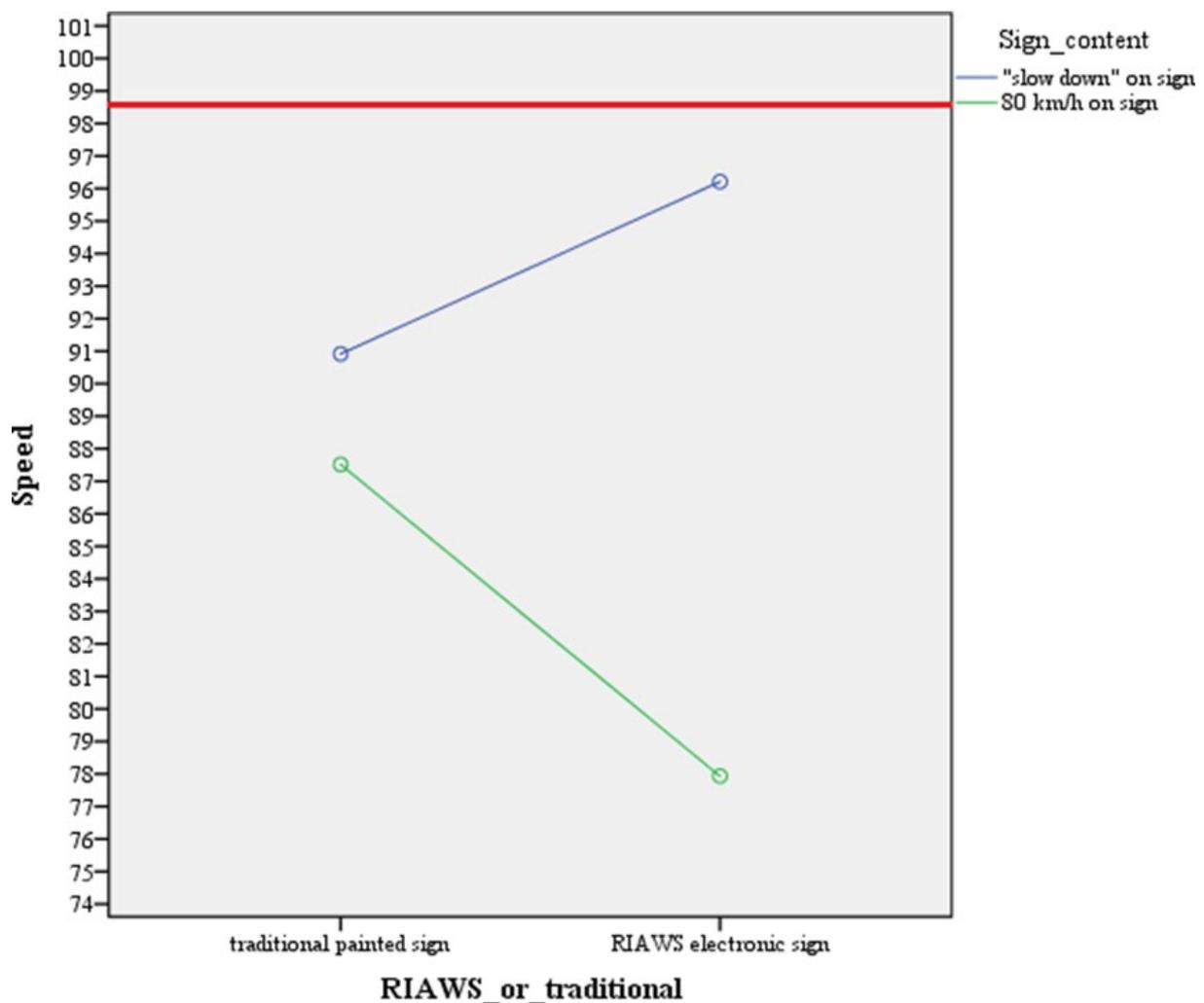
**Figure 1. Electronic RIAWS 80 km/h speed limit sign and RIAWS slow down sign**

The simulated driving scenarios consisted of 3D models, which represented approximately 1070 kilometres of the generic rural environment in WA. The simulation consisted of midblock sections of road with posted speed limits of 110km/h. There was a left-turn pocket, which led into a side road on the left at the intersection. The participant was instructed to drive straight ahead and not to turn into the side road. As the participant approached the intersection, a vehicle approached the intersection from the left side of the road, always stopping before the intersection. The driving scenarios were simulated for day time driving only. A total of eight possible driving scenarios were created containing different combinations of the intersections. Each scenario contained a total of four intersections, with two different signed sites and two unsigned control sites per scenario, randomly presented.

A convenience sample of 96 Perth-based drivers aged between 18 to 80 years who held a current WA C class (passenger vehicle) licence were tested. They were recruited from the local universities, social media and radio advertisements. Inclusion criteria stipulated that each participant had been driving a motor vehicle for at least one year; drove at least three times a week; lived in the Perth metropolitan area, were able to attend a driving simulator assessment and had not moved interstate or from overseas in the past twelve months. Participants were instructed to drive as they normally would and participants were not told in advance the purpose of the study. It took approximately 10 15 minutes to complete the drive.

**Results**

A repeated measures two-way ANOVA was undertaken to explore the interaction of the signage type (RIAWS versus traditional painted) and sign content (80km/h versus slow down) on instantaneous speed (speed measurement captured at the exact location of the sign or corresponding location). There were significant differences for RIAWS “slow down signs ( $p < 0.001$ ), traditional painted “80km/h” signs ( $p < .05$ ) and traditional painted “slow down” signs ( $p < 0.001$ ). The RIAWS “slow down” sign resulted in a significant difference compared to a traditional painted “80km/h” sign ( $p < .05$ ) and there was no significant difference for traditional painted “slow down” signs ( $p = 0.396$ ). There were no significant differences in speed between traditional painted “80km/h” signs and traditional painted “slow down” signs ( $p = 0.745$ ).



**Figure 2. Mean instantaneous speed by speed sign type and content (Red line = mean value for unsigned control sites)**

## Conclusions

Overall, the study found that RIAWS “80km/h” sign provided the most effective option for reducing driver speeds on approach to rural intersections. As speed reduction is the main aim of installing the RIAWS at rural intersections, the study results are highly encouraging and suggest that the RIAWS system tested here may be a useful road safety treatment on high speed rural roads like those found in WA. However, care should be taken in selecting the message as the “slow down” message resulted in significantly higher instantaneous speed than a traditional painted “80km/h” sign.

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## **Increasing awareness of distracted pedestrians at railway level crossings with illuminated in-ground lights**

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### **Abstract**

Pedestrian distraction is a growing problem. Current signage at railway level crossings may not be effective for pedestrians distracted by mobile devices, as it is designed for users looking ahead when walking rather than looking downwards as when using a mobile. Illuminated in-ground lights are an innovative solution to address this issue but have not been evaluated for use with distracted pedestrians. We conducted a 2 (in-ground lights yes/no) x 3 (distraction task none/auditory/visual) repeated measures field study (N=34) at a railway level crossing to assess whether distracted pedestrians could detect illuminated in-ground lights and how this impacted on visual scanning behaviour. Pedestrians detected the lights as accurately when distracted (visually or auditorily) compared to when not distracted, and eye scanning behaviour of the rail tracks with the in-ground lights was the same as for non-distracted levels. This is the first study to suggest that illuminated in-ground lights could be effective in attracting the attention of distracted pedestrians at railway level crossings.

### **Background**

One major contributor to pedestrian risk of injury and death at railway level crossings is when pedestrians are complacent, distracted or inattentive (Edquist, Stephan, & Wigglesworth, 2009; Larue, Naweed, & Rodwell, 2018). Distraction and inattention tend to become more prevalent with increased usage of mobile phones and headsets. The current form of pedestrian protection at railway level crossings is a sign, sometimes associated with pedestrian barriers and a warning bell when the crossing is actively protected. The effectiveness of such warning devices is likely to be reduced by the increased usage of mobile devices and headphones.

An innovative solution to combat the issue of distracted pedestrians is the use of visual warning lights installed in the ground. Such devices are installed at road intersections and have been trialled in some locations around the world (Potts, 2016; Sulleyman, 2017; Timson, 2016). While affective at attracting the attention of distracted participants in laboratory conditions (Larue, Watling, Black, Wood, & Khakzar, 2020), there has currently been no publicly-available field-based evaluations of the safety improvements obtained from such interventions for level crossings or other intersections. This research aimed to evaluate pedestrians' accuracy in detecting illuminated in-ground LEDs and their scanning behaviour toward railway crossings while conducting a distracter task with a mobile device or headphones.

### **Method**

A field study was conducted at a railway level crossing in New Plymouth, New Zealand, where in-ground lights had been installed. Participants included 34 individuals (mean age: 33.6; SD=8.6) who were regular users of mobile devices while walking. The research design consisted of six different conditions, which were randomly ordered across participants, which investigated pedestrian behaviours without (control) and with in-ground lights at the crossing (Figure 1) for different types of distraction induced by a mobile device (none, visual, and audio). The in-ground lights comprised yellow flashing lights, which were activated by the movement of pedestrians as they entered into the

maze of the level crossing. Once activated, the lights flashed for 10 seconds, alternating every second. The distractor tasks were simple reaction time tasks requiring the participant to tap on the smartphone; these tasks were similar to those used by Larue et al. (2020). Participants walked through the crossing six times for each condition. Participants wore eye tracking glasses and their accuracy in detecting the in-ground lights, as well as their gaze behaviour towards the crossing was recorded. Appropriate scanning behaviour consisted of looking for trains on both sides before entering the crossing. Statistical analyses were conducted with Generalised Linear Mixed Models.



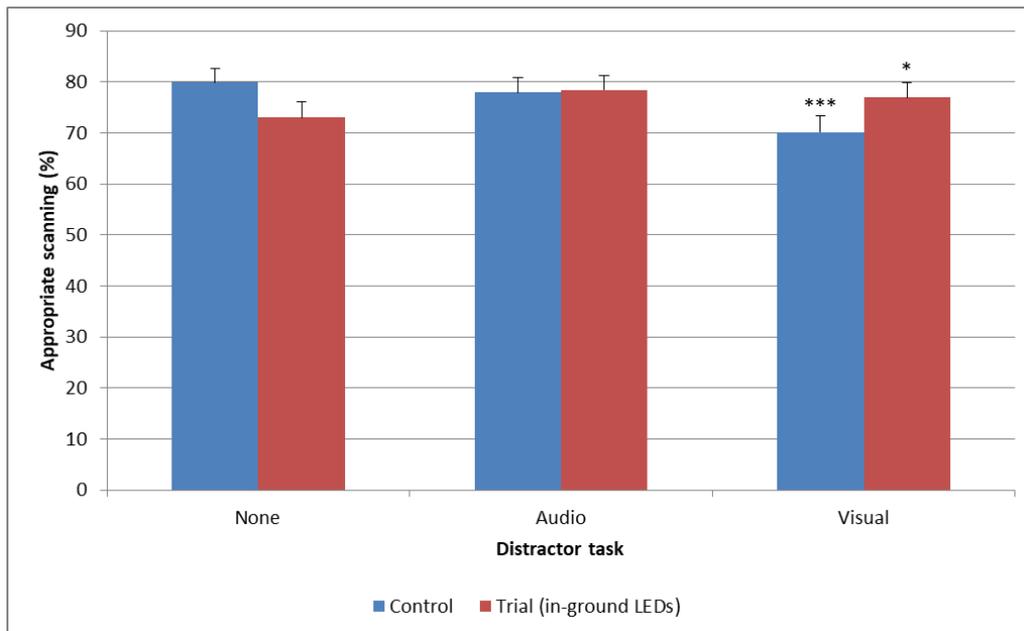
**Figure 1. View of the level crossing (Left: Trial configuration (with in-ground lights); Right: Standard (control) configuration)**

## Results

Participants were shown to be engaged in the distractor task, and their behaviour observed at the crossing reflected that of distracted pedestrians: they responded with high accuracy (above 90%) and rapidly (in less than a second) to the distractor task. With the visual distractor task at the control crossing, the duration of down gazes tripled while approaching the crossing, from 3 to 9 seconds ( $t=28.38$ ,  $d.f.=945$ ,  $p<.001$ ) compared to when not distracted, and significantly reduced scanning behaviours toward the rail tracks, with participants being significantly more likely to fail to check for trains ( $t=-4.96$ ,  $d.f.=1,188$ ,  $p<.001$ ) (Figure 2). These effects were not observed with the audio distractor. The addition of in-ground lights attracted the attention of pedestrians, even when they were distracted, with detections between 94% and 96% in all distracted conditions. Adding the lights did not affect scanning behaviour with the audio distractor task, but slightly decreased scanning behaviour with the visual task ( $t=2.07$ ,  $d.f.=1,188$ ,  $p=.038$ ). The behaviour was however very close to the control condition, and much better than when visually distracted without the in-ground lights.

## Conclusions

This study highlighted positive effects of illuminated in-ground lights at railway crossings in terms of attracting the attention of pedestrians who were visually or auditorily distracted by a mobile phone. It also improved train scanning behaviour when visually distracted: with the flashing lights, the scanning performance while distracted was similar to that when not distracted. Our study is the first to demonstrate that an in-ground light intervention at a railway crossing could be effective in attracting the attention of distracted pedestrians. This study used a repeated measure design and learning effects may have an impact on the findings. Further studies should be conducted to confirm these positive effects in a more naturalistic setting. Given the rapid increase in pedestrian distraction with mobile devices, this approach shows promise for reducing the risk of fatalities and major injuries.



**Figure 2. Percentage of appropriate scanning behaviour towards rail tracks with Standard Error of the Mean (statistically significant differences are highlighted: \*\*\*  $p < .001$ , \*  $p < .05$ ).**

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## Road Safety Gains from Small speed Reduction Wheatbelt Road in Rural WA

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Main Roads Western Australia Northam, Western Australia

### Abstract

Safe roads and roadsides, safe Speeds, safe vehicles and safe people are cornerstones of the road safety system (Cairney, Imberger, Turner, 2013). When providing safe roads and roadsides, road geometry is a vital factor, in assessing the suitable speeds that most vehicles operate on the road (Semeida, 2013). For low volume, rural roads with substantial substandard geometry compared to the posted speed, geometric improvements are not justified due to the high cost. A better approach would be speed management. This case study focuses on the Chidlow York Road, a 44km long regional, freight, tourist and inter-town route in the Main Roads Wheatbelt Region of Western Australia. This road is known for its poor geometry; 110km/h posted speed and carries around 2000 vehicles daily. Reducing the speed limit by 10km/h to 100km/hr along with minor improvements, a crash reduction of 34% was observed (IRIS database, 2019).

### Speed Reduction

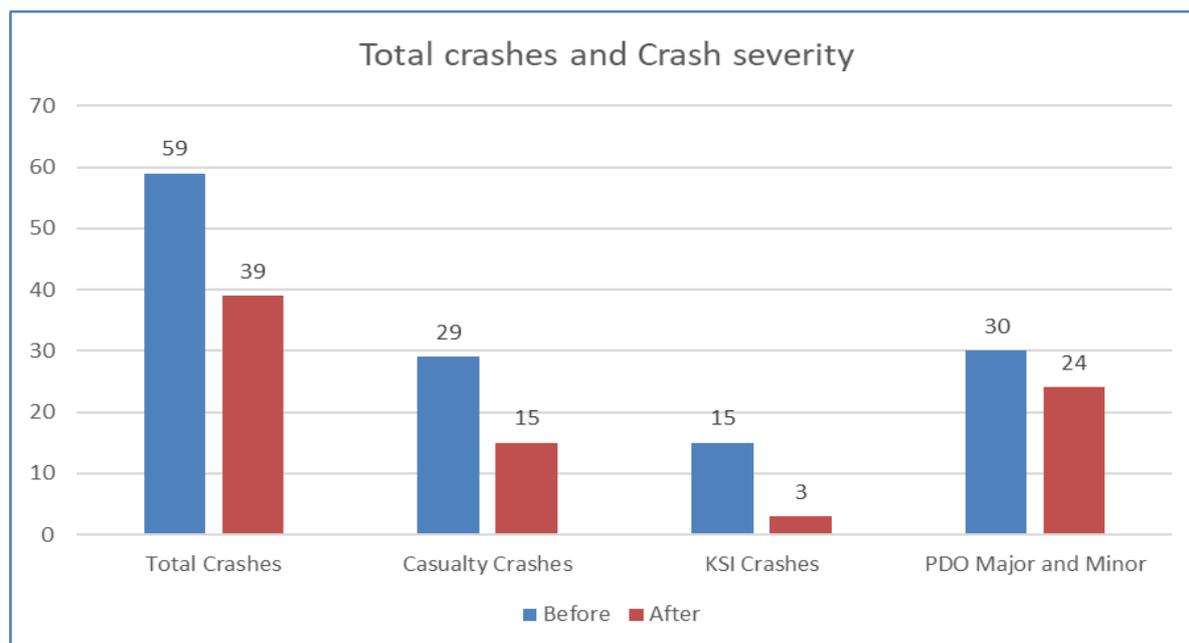
In regional Western Australia (WA), 4147 people were killed or seriously injured (KSI) between 2013-2017. 941 were from the Wheatbelt Region with sixty-six percent of people killed or seriously injured occurred on roads with 110 km/h speed zones. (Road Safety Commission, 2019)

Chidlow York Road is a state regional road in the Wheatbelt Region road network. This road is classified as a primary distributor road and carries 2178 vehicles daily with 34% heavy vehicles. The speed zones in place are predominantly 110 km/h with short sections of 90, 80, and 60km/h. This road is a single carriageway with one lane in each direction and is currently approved for Restricted Access Vehicle up to Network 4(RAV-4) (IRIS database, 2020).

Chidlow York has substandard roadway geometry, and the road's seal and formation width are average 3.2m lanes with sealed shoulders of average 0.5m. There is substandard vertical and horizontal alignment along the entire length. The high proportion of existing horizontal curves are too short for the relevant design speed and the radius or super elevation too severe to safely accommodate heavy vehicle movements. The road runs through parks and reserves and there are many threatened fauna and rare flora sites within the extent of the road reserve. There are trees that obscure the clear zone recovery. This road runs East-West, making it subject to considerable glare in the early morning and evening.

The safety performance of this road was abysmal. It was ranked number two of the top five roads in the Wheatbelt Region on KSI crash densities between 2009 and 2013. There were 13 serious crashes in which five people were killed and 12 people seriously injured over this period. (Wheatbelt Highway Safety Review, 2015).

Although road geometry improvement is the ultimate solution to improve the safety risk, it is cost-prohibitive as the majority of the road is substandard. Environmental constraints limit the possibility of improving safety risk. Progressive road development requires long term planning and was not a solution to escalating road safety. The main modification made on Chidlow York



**Figure 1:** Total Crashes and Crash Severity Chidlow York Road before and after safety improvements

Road was a speed reduction of 10km/h, along with minor improvements including audible edge line, shoulder sealing of a few locations and improvements to road curve signage. These modifications were deemed as the most sustainable approach for Main Roads to improve road safety without significant impacts on travel time and in a cost-effective manner. Post-implementation monitoring three years before and after shows a significant reduction of severity of crashes has occurred. This is displayed in Figure 1. The total crash numbers have reduced from 59 to 39 representing a 34% reduction. PDO Major and Minor crashes were at 30 and decreased to 24. This displays a shift of casualty crashes (29 to 15) to PDO major /minor crashes. Furthermore, previous PDO major crashes may have shifted to minor or no crashes at all. Overall, this explains the decreasing crash severity on Chidlow York Road resulting from safety measures implemented. This strategy will be considered for similar situations within the Main Road's Wheatbelt Region road network.

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## Automated detection of roadside hazards using Lidar

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### Abstract

Main Roads Western Australia undertook development of AusRAP star rating using existing corporate inventory data to meet reporting commitments to the National Road Safety Strategy. Throughout this work, both the advantages and limitations for using inventory data were highlighted. One such issue is with detection and identification of roadside hazards (e.g. trees, power poles, buildings). Therefore, Main Roads has partnered with Anditi to test the potential for automating the detection of road and roadside features using mobile Lidar and 360° imagery data. Two thousand kilometers of state road network have been selected, broken into five categories with differing roadside archetypes. Analysis conducted can detect and identify various roadside hazards, and even differentiate between tree trunks and power poles. This fresh innovative approach to data sourcing for safety risk assessment has real potential and may ultimately help towards the development of up-and-coming tools such as ai-RAP.

### Background

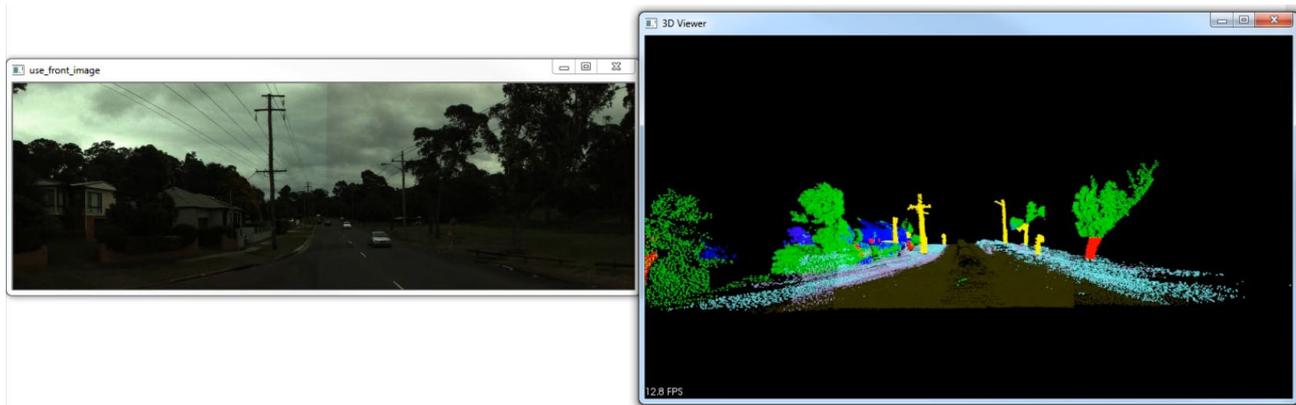
The National Road Safety Action Plan 2018-2020 provided the impetus for Main Roads WA to AusRAP star rate the entire state network. Which was done using nearly entirely corporate inventory data rather than the traditional method of manual visual coding of video surveys. This process highlighted both the potential, and the associated issues with using a different data source to those traditionally used. One of the major issues was around the sourcing of roadside hazard data. With the advancement in Lidar and other technologies, we must have the ability to automate the detection of roadside hazards and other road attributes. This is exactly the aim of this project. Main Roads WA partnered with Anditi to automate the collection of road and roadside features using mobile Lidar and 360° imagery data.

### Methodology

This project tests Anditi's system to automate the identification and extraction of roadside hazard and asset information on 2000km of WA state road network, using off-the-shelf TomTom MoMa data captured in 2016-2018. Roads were selected from across the state with differing road type, namely control of access highways, urban highways with high density of roadside objects (i.e. houses and bus stops), fringe highways (outer metro into rural with more industrial land use), rural roads in both open and more forested areas. This ensured a range of feature types and environments would be encountered to help test the automated system of feature extraction. The main features for extraction include roadside hazards and their distance from roadside (e.g. trees, poles, buildings and barriers), median type and width (e.g. physical raised median), detection of roundabouts, presence of audible centerlines, presence of street lighting and identification of property access points.

### Results

Key road and roadside attributes targeted as part of the study were successfully identified in the mobile LiDAR and 360-degree imagery, and extracted into iRAP compatible format. Figure 1 clearly shows the detection and identification of various roadside hazards. The algorithms detected the difference between tree trunks (shown in red) and power/light poles (shown in yellow) (Figure 1).



**Figure 1. Preliminary results of automated detection of roadside features. On the left is the video image, and on the right is the Lidar data with different roadside features coloured differently i.e. tree trunks are red and power/light poles are yellow.**

This study increased the understanding of the challenges of working with ‘off the shelf’ MoMa data and what is required for attribute detection. Challenges included level of scatter and misalignment in point cloud. The study found that these could be rectified through additional processing and correction of the data. As a result, TomTom are implementing measures to improve their data.

Outcomes of the study show that with further development and automation combined with good quality data the full range of physical attributes required for iRAP Star Rating could be automatically extracted from remote sensing data including mobile LiDAR, 360-degree imagery and satellite imagery. Additionally, the process utilised for this study can be undertaken in a scalable, efficient and cost-effective manner.

### **Implications and next steps**

Using Lidar and 360° imagery data to detect, extract and identify road and roadside features is innovative and demonstrates a fresh approach to data sourcing for safety risk assessment. Furthermore, this process allows for cost savings and efficiencies of scale for capturing features that have implications outside road safety for example asset management.

iRAP itself is investigating the development of ai-RAP, which aims to use accelerated and intelligent collection and coding of road attribute data to reduce time and effort, and improve accuracy of road safety assessments. Although this is still in early stages, there is exciting progress to come and we hope to help in making this potential a reality.

## Using road inventory data to produce AusRAP star ratings

Fritha Argus<sup>a</sup>

<sup>a</sup>Main Roads Western Australia

### Abstract

Actions 2 and 3 of the National Road Safety Action Plan 2018-2020<sup>1</sup> collectively aim to reduce risk associated with infrastructure by setting targets for the proportion of travel on state and national routes with 3-star (or better) AusRAP star ratings. In order for Main Roads Western Australia to determine how the state is progressing towards these targets, it first needed to rate the network using AusRAP. As funding for video coding was unavailable, an AusRAP upload file was developed using existing corporate inventory data. This project established business and coding rules to convert inventory data into AusRAP fields. This has enabled the entire state road network to be AusRAP star rated at a fraction of the cost of video coding.

### Background

It is very important for road authorities to understand the safety risk on their road network. AusRAP, the Australian arm of the international road assessment program (iRAP), provides a well-known method for assessing risk based on road infrastructure and roadside features. Unfortunately, as iRAP is a global program it caters to developing countries that may not have reliable, accurate data about their road network. As such, iRAP traditionally uses data coded by manual visual assessment of video surveys. This introduces its own issues and limitations, namely costly, timely, human error and subjectivity due to the manual nature of data collection. Cost can be particularly restrictive for road agencies that already have corporate inventory data stored and maintained in house.

The National Road Safety Action Plan 2018-2020 has actions (namely 2 and 3) which collectively aim to *improve the star ratings across the whole road network, with the aim to achieve 3-star AusRAP ratings or better for 80% of travel on state roads, including a minimum of 90% of travel on national highways*. This provided an impetus for Main Roads WA to star rate the entire Western Australian state network.

### Purpose and Description of the Project

This project aimed to use existing corporate inventory data to define, develop and write business and coding rules to prepare an AusRAP file for upload into Vida.

All coding was done using SAS, and data sources, business and coding rules were documented to ensure the process could be replicated. The rules were developed to replicate the intent of the iRAP coding manual. Once coding was complete, data was uploaded to Vida. Validation was conducted against the 2014 AusRAP assessment of the national highways (funded by RAC WA), and also against a small subset (1,596.5km) of WA state network that was recently video coded.

### Implication and Conclusions

The entire WA state network was assessed using AusRAP methodology. Some road sections had missing data for one or more of the 78 fields. However, ultimately 17,479.36km (of 19,315.97km) of road was star rated. Validation of core features and overall star ratings found minimal difference between the video and inventory derived files.

Using inventory data and coding to automate the extraction, manipulation and categorisation of data into AusRAP fields is not only possible, but a very worthwhile exercise. Determination of specific

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<sup>1</sup> [https://www.roadsafety.gov.au/sites/default/files/2019-11/national\\_road\\_safety\\_action\\_plan\\_2018\\_2020.pdf](https://www.roadsafety.gov.au/sites/default/files/2019-11/national_road_safety_action_plan_2018_2020.pdf)

coding rules can be refined as more people move into this space. In particular, iRAP have announced that they will be working towards developing  $\alpha$ i-RAP, which will not only automate the coding of variables but also the collection of data from various sources including Lidar.

Furthermore, mobility advocate groups in WA are reviewing the process and are interested in using this inventory data based star ratings. AusRAP star ratings will likely be used in WA for high-level reporting of the safety performance of the overall network, including the National Highways, and for assessing the potential safety performance of large greenfields projects and large rural road safety programs.

# Using road inventory data to produce AusRAP star ratings

Fritha Argus  
Main Roads WA

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## AusRAP star rating system



AusRAP, as part of the iRAP family, is widely understood and accepted, and therefore increasing accessibility to this form of risk rating is vital.



1. Enabling road agencies to risk assess their network will enable limited funding to be targeted to areas that will have the greatest impact on reducing risk to road users.
2. Increasing accessibility to AusRAP can be best achieved through reducing costs of risk assessment by using existing data sources.
3. It is achievable and cost effective to develop AusRAP fields through coding of existing inventory data.



## **Self perception, driving patterns and gender differences on psychological measures of young Indian drivers**

Guneet Singh Assi

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Post Graduate Institute of Medical and Educational Research (PGIMER), Chandigarh, India.*

### **Abstract**

A study of 395 young Indian drivers (199 males and 196 females) exploring their socio-demographic profile along with gender differences was conducted. Differences among male and female drivers on several parameters were sought. This study provides an insight into what sets male and female drivers apart on their driving license patterns, perceptions of their own self on being aggressive, risk-taking or an unsafe driver. The socio-demographic profile looked into their driving license and driving test parameters. Psychological constructs of driving anger and dangerous driving were administered to the participants. The findings reveal that there were significant gender differences on sub-scales of driving anger, where females were found to experience anger on the hostile gestures of other drivers on roads. Significant gender differences on the sub-scales of dangerous driving was also found where males were found to score higher on dimensions of aggressive and risky driving than their female counterparts.

### **Background**

Road crashes are the leading cause of death among young people aged 15-29 years. More than a million people die annually in road crashes globally and every day nearly 3400 people lose their lives on the roads worldwide (World Health Organization, 2013). Over 90% of all road fatalities occur in low and middle-income countries, which have less than half of the world's vehicles. Contributory factors to road traffic crashes have been found to be due to behavioural, environmental and vehicular failures (Sabey & Taylor, 1980). In the majority of traffic related crashes, human error has been cited as a major causal factor which makes it imperative to study the driving behaviour of people. Considering that the young drivers play a major role in traffic related crashes in India raises a cause for great concern (Gururaj G, 2017). As much of the research is conducted in Western nations, this study aims to fill the gap by adding to the literature on road safety on young Indian drivers.

### **Method**

The data was collected from various colleges of Chandigarh, Panchkula and Mohali (India). Purposive sampling was used where the researcher went to various colleges and conducted the study where permission was granted. The participants of the study included students who were in the age group of 18-23 years, driving a motorized vehicle (both two-wheeler and four-wheeler) and were willing to participate in the study were recruited and were given the standardized questionnaires in groups. Data was collected by a trained researcher during the subject's routine classes subject to prior permission from the concerned authorities. The participation was voluntary and full confidentiality was ensured. A socio-demographic questionnaire together with standardized scales on driving anger (The Driving Anger scale by Deffenbacher *et al.*, 1994) and on dangerous driving (Dula dangerous driving index (DDDI by Dula & Ballard, 2003) were used.

### **Results and Conclusions**

The socio-demographic profile of male and female drivers revealed interesting revelations that caught attention like quite a proportion of drivers were on roads with no driving license, female drivers

confessing the most. Psychological tests for constructs of driving anger and dangerous driving were administered to the participants. The findings reveal that there were no significant gender differences on driving anger but only on one of its sub scale of hostile gestures. On dangerous driving, two of its sub-scales, aggressive and risky driving showed significant gender difference with male drivers expressing the same on roads in contrary to their female counterparts.

The study highlights the need for more stringent driving licensing procedures, the need to make parents aware on road safety especially the father who has a major role in shaping the driving skills of his child. It also points out the laxity on the part of female drivers who are not often checked or stopped by the traffic police, to be more traffic rule compliant and avoid anger expression on roads. Young drivers through massive awareness campaigns need to be made aware the significance of being a safe driver, an incentive program for them on same lines can also reap results.

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## **Local Government supporting and reinforcing workers returning home safely: Case Study of John Holland–Batemans Bay Bridge replacement project**

<sup>a</sup>Kate McDougall, <sup>b</sup>Janette Pritchard

<sup>a</sup>Eurobodalla Shire Council, <sup>b</sup>John Holland

### **Abstract**

Eurobodalla Shire Council (ESC) collaborated with construction company John Holland's Batemans Bay Bridge replacement project team, implementing Towards Zero "Road Safety and Your Work; a Guide for Employers"<sup>(1)</sup> (TZRSAYW). After assessing road safety risks within the John Holland workforce, driver fatigue was targeted as 55% of project workers live outside the Eurobodalla and travel home regularly.

Driver fatigue in Eurobodalla accounts for 23% fatal and 11% casualty crashes 2014 to 2018.

Due to unprecedented bush fires in 2019-2020 in Eurobodalla, additional Towards Zero messages were delivered to ensure the safety of workers travelling home from the workplace, particularly on weekends and peak holiday times.

### **Background**

In NSW approximately one quarter of road fatalities involve business vehicles, primarily a car or light truck. In the ESC local government area driver fatigue accounted for 23 per cent of fatalities and 11 per cent of casualties from 2014 to 2018. In NSW most fatigue-related road incidents involve males aged 17 to 49 years and people aged over 50 years. As 87 per cent of John Holland's workforce consists of men, fatigue was identified as the main road safety risk that needed addressing through workforce education

ESC road safety officer liaised with John Holland Community Relations Manager at Batemans Bay inviting John Holland to participate in the TZRSAYW practices as they have been awarded the design and construct contract in delivering Transport for NSW \$274 million Batemans Bay Bridge replacement, building better connections in and around Batemans Bay for motorists, freight, river users, pedestrians and cyclists. Major work started in early 2019 and planned to be complete in early 2023.

Caring for workers and communities where projects are delivered is fundamental to John Holland. John Holland is committed to ensuring all workers return safely home every day. Through the Local Government Road Safety Program (LGRSP), Council is collaboratively working with John Holland to ensure these things happen.

Upon receiving the contract for the Batemans Bay Bridge replacement project, John Holland's workforce quickly grew from 50 full-time equivalent workers to 165. The

workforce has reduced to approximately 110 after completion of the pre-cast operation in October 2020.

### Method

Council, through the NSW Road Safety Program (LGRSP), deliver statewide programs at a local level, including TZRSYW. To support the Towards Zero campaign John Holland, through their Health and Safety policy, promote:

“That all our employees should trust that they will return home safely each day.

To achieve this, we promise to:

- Put safety first, always;
- Show our commitment to safety in every action we take;
- Make safety personal, always.”

ESC’s road safety officer facilitated a pre-start safety meeting discussion at each of the company’s locations with John Holland workers highlighting the warning signs of fatigue and impact of fatigue on driver performance. (Table 1) Branded re-useable coffee cups with the NSW Government “Don’t Trust Your Tired Self” slogan were also distributed to project workers attending for use while travelling. (Picture 1)



**Picture 1. John Holland workers and Council’s road safety officer holding keep cups with fatigue messages**

Due to unprecedented bush fires from November 2019 – February 2020, impacting the bridge project area and access in and out of Batemans Bay, John Holland’s leadership team delivered additional road safety messages about safe travel in the holiday season. These discussions encouraged the project’s workforce to demonstrate safe driving habits including how to identify fatigue warning signs. The discussions were delivered at each of the project’s worksites in late 2019 during daily pre-start meetings.

Location	Date held		Number of Staff attending
Pre-Cast facility	15.10.19		45
Northern compound	25.10.19		45
Main site compound	1.11.19		75

**Table 1. Time and date of pre start safety meeting held by John Holland and Council to discuss road safety, in particular fatigue.**

## Results

The project workforce safely returned to the worksite following the 2019-2020 Christmas New Year project shutdown period without incident, noting the effectiveness of the workplace road safety campaign. A continued coordinated approach between Council and John Holland during 2020 and 2021 has helped all members of the bridge project team remain more road safety aware.

## References

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<https://www.rms.nsw.gov.au/projects/batemans-bay-bridge/index.html>

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## **Real World Application of Crash Data from Vehicle Event Data Recorders - A Case Study**

Michael Hardiman<sup>a</sup>

<sup>a</sup>Victoria Police Forensic Service Department – Collision Reconstruction and Mechanical Investigation Unit

### **Abstract**

The use of crash data obtained from Event Data Recorders (EDRs) has grown significantly since their introduction in 1997 and is now considered an integral element of collision reconstruction. EDR data has been accepted in criminal cases in the USA, England and Australia (Technavio, 2017), with Victoria Police (VP) presenting crash data in criminal matters since 2010. The use of this data has provided corroboration of existing reconstruction methods and previously unknown information where there is no physical scene evidence. In this case, two vehicles, both equipped with EDRs were involved in a collision at a signalized intersection, resulting in the death of two occupants in one vehicle. The data obtained from the EDR was shown to be highly accurate and robust, leading to a successful prosecution. The devastating loss of life in the high-speed collision detailed in the case study highlights the true value of the information obtained from EDRs.

### ***Circumstance***

On Saturday the 21<sup>st</sup> of April 2018 at 1:10 am, a two-vehicle fatal collision occurred in Boronia, Victoria. The collision involved a stolen 2016 Lexus LX570 station wagon driven by an unlicensed 19-year-old male person, with a female front seat passenger, that was travelling in a southerly direction. The second vehicle was a 2008 Holden Commodore sedan driven by a male with a female front seat passenger, travelling in an easterly direction. The collision has occurred within a major signalised intersection, with the Commodore and Lexus coming to rest on the south east side of the intersection, between 31 and 40 meters from the area of impact. As a result of the collision, both occupants of the Commodore received fatal injuries, while the Lexus occupants were uninjured, leaving the scene before being arrested days later.

### ***Collision Reconstruction***

The collision was attended by a Police reconstructionist, who assisted in determining relevant scene evidence, including road scars, vehicle damage, tyre marks and roadway drag factor. The scene was documented by photographs, video (Go-Pro), a site survey with a Trimble S6 Robotic total survey station and 3D scan using the Riegl VZ-400i laser scanner. CCTV footage and traffic light sequence data was later identified, retrieved and analysed.

Additionally, vehicle weights, post impact speeds and both vehicles entry and exit angles were determined, allowing the speed at impact of both vehicles to be determined using a 360° momentum analysis. Based on the assumption the Commodore was travelling at 80km/h, the analysis revealed the Lexus was travelling at approximately 114 km/h at impact.

### ***EDR retrieval and analysis***

Both vehicle EDRs were supported by the Bosch Crash Data Retrieval (CDR) system. Due to vehicle damage, both EDRs were removed and successfully downloaded via direct to module imaging. Data obtained from the Commodore showed that for the 2.5 seconds prior to impact, the vehicle maintained a constant 77 km/h and at no time in the 2.5 seconds pre-crash did the driver brake. Delta-v data showed the vehicle had undergone a speed change of 61.8km/h in 200 m/s. Five seconds of pre-crash data was obtained from the Lexus which showed at impact, the vehicle was travelling at 114km/h. In the 5 seconds prior to impact, the vehicle speed recorded a maximum of 133 km/h, with 100%

accelerator pedal position (Refer table 1). The driver made an emergency brake and steering input in the 0.2 seconds prior to impact. Delta-v data showed the vehicle had undergone a speed change of 43km/h in 200 m/s.



*Figure 1. Collision scene showing post impact marks and rest position of vehicles*

*Table 1. Extract of EDR data retrieved from Lexus*

Pre-Crash Data, -5 to 0 seconds											
Time (sec)	-4.7	-4.2	-3.7	-3.2	-2.7	-2.2	-1.7	-1.2	-0.7	-0.2	0
Vehicle Speed (MPH [km/h])	82.6 [133]	80.8 [130]	77.7 [125]	75.8 [122]	73.9 [119]	71.5 [115]	70.8 [114]	71.5 [115]	72.7 [117]	72.7 [117]	70.8 [114]
Accelerator Pedal, (% Full)	0.0	0.0	0.0	0.0	0.0	0.0	14.0	100.0	100.0	0.0	0.0
Engine RPM (RPM)	3,600	3,500	3,400	3,300	3200	3,700	3,700	4,400	5,100	4,900	4,700
Service Brake, ON/OFF	ON	ON	ON	ON	ON	ON	OFF	OFF	OFF	ON	ON
Brake Oil Pressure (Mpa)	2.59	2.45	2.40	2.06	1.97	2.02	0.00	0.00	0.00	1.54	10.22
Steering Input (degrees)	-6.0	-6.0	-3.0	-3.0	0.0	0.0	1.5	0.0	9.0	-25.5	-15.0

### ***Conclusion***

The EDR evidence was instrumental in the successful prosecution of the driver for Culpable Driving and an imposed sentence of 13 years. EDR data can lead to an improvement in driver behaviour through awareness of its existence, as well as providing vital real-world collision information to researchers, vehicle designers and investigators for use in injury prevention, upgraded vehicle safety features or criminal prosecutions.

### ***Citations***

Technavio (2017), *Global Automotive Event Data Recorder Market: 2017-2021*, Technavio, publication available upon request at <https://www.technavio.com/report/global-automotive-electronics-globalautomotive-event-data-recorder-market-2017-2021>

## Drink driving attitudes and behaviours in NSW

Rhiannon Kelly<sup>a</sup>, Nathan Rath<sup>b</sup>, Florence Le Guyader<sup>b</sup>, David Elliot<sup>b</sup>, Lucy Filardo<sup>a</sup>, Ralston Fernandes<sup>a</sup>, Louise Higgins-Whitton<sup>a</sup>

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### Abstract

Drink driving remains problematic in NSW, contributing to 17% of road fatalities in 2019. A sample of 2,133 NSW drivers was surveyed regarding their attitudes and behaviours towards drink driving. Twenty-five per cent had driven over the legal blood alcohol concentration (BAC) limit in the last six months, up from 18% in 2014. Prevalence of drink driving was higher for those aged 16-25, especially for regional-based females (50%). Drink drivers were more likely to endorse driving over the legal BAC limit in certain situations such as driving on quiet roads or short distances and were less likely to think they would get caught. However they were more likely to be aware of new drink driving penalties introduced in 2018-19, and to say these would deter them from drink driving. NSW drink driving campaigns are currently being reviewed with the aim of incorporating these findings into future education and awareness campaigns.

### Background

While alcohol-related road fatalities in NSW have trended downward since the 1980s, this trend has flattened more recently and drink driving remains a key contributor to road trauma in NSW. This research investigated current attitudes and behaviours towards drink driving in NSW, to inform strategies to reduce alcohol-related road trauma. This builds on similar research conducted in 2014.

### Methods

A sample of 2,133 NSW drivers aged 16 and over who consume alcohol at least once every month completed a fifteen-minute online questionnaire regarding drink driving attitudes and behaviours. Age, gender and location quotas were used to ensure the sample was otherwise representative of the NSW driving population. Participants were sourced from a panel and received an incentive for their participation.

### Results

#### *Prevalence*

The proportion of NSW drivers who had driven over the legal BAC limit ('the limit') in the last six months, either when they knew they were, or when they might have been, has increased from 18% in 2014 to 25% in 2019. Prevalence was particularly high for drivers 16-25 years old (39%), including for both metro-based females and males (35% and 38% respectively), and regional-based females (50%).

#### *Situational-related attitudes*

Drink driving appears to be related to certain situational factors, with drink drivers\* more likely than NSW drivers overall to agree that: driving on quiet roads is ok if you are a bit over the limit (76% vs. 53%); they would drive over the limit because they need the car the next morning (36% vs. 18%); and they would drive home 'a bit over the limit if it wasn't far' (40% vs. 16%). Drink drivers were less likely to think it was 'likely' they would get caught (57% vs. 62% overall), with many (36%) saying that random breath testing is not done often where they live.

### *Awareness of new penalties*

In 2018-19, a number of new drink driving penalties were introduced to further deter drink driving in NSW. Compared to all drivers, awareness of all these penalties was higher for drink drivers\* and approval was lower; however drink drivers\* were more likely to be deterred by these penalties. For example, 51% said that number plate confiscation and vehicle impounding for repeat and high-risk drink driving offences would make them “a lot less likely to risk drink driving” (vs. 30% overall). However, only 34% of drink drivers and 28% of NSW drivers overall were aware of this penalty.

### **Conclusions**

One-quarter (25%) of NSW drivers admitted to drink driving in the last six months, up from 18% in 2014, indicating a need to refocus prevention efforts. Prevalence is particularly high in females aged 16-25 and drink driving also appears to be associated with certain situational-related attitudes. NSW’s drink driving campaigns are being reviewed in line with these findings and changes will be made to target situational-related attitudes, and increase awareness of the new penalties. Further research is recommended to better understand the high prevalence of drink driving in females aged 16-25, to inform targeted campaigns for this group.

\*Note: ‘drink drivers’ includes those who answered yes to having done at least one of the following – driving *knowing* they were over the legal blood alcohol concentration limit, or driving when they think they *might have been* over the legal blood alcohol concentration limit, in the last six months.

## **Findings on Child Restraint System (CRS) use in Dubai, United Arab Emirates**

Inam Ahmad, Brian Fildes, David B. Logan & Sjaan Koppel

Monash University Accident Research Centre, Monash University, AUSTRALIA

### **Abstract**

This study aimed to investigate parents' attitudes, knowledge and behaviours relating to safe child occupant travel in the Emirate of Dubai in the United Arab Emirates (UAE). A survey was conducted with 815 parents/carers who were responsible for 1,694 children (aged between birth and 10 years) to investigate their use of child restraint systems (CRS) and booster seats for their children, their self-reported use of appropriate restraints for their child's age-group, issues regarding restraint selection and installation, and knowledge regarding the restraint legislation. Overall, 20.6 percent of participants reported that they 'never' used a CRS and booster seat for their eldest child who was aged 10 years or younger while travelling in a motor vehicle. In addition, the proportion of eldest children who were 'never' restrained increased with their age. Future research will validate this self-reported child restraint use data with objective data from observations of real-world child restraint use behaviour in UAE.

### **Background**

According to Department of Health of Abu Dhabi in the United Arab Emirates (UAE), two out of every three fatally injured children die as a result of motor vehicle crash, which is around three times the global average (Health Authority Abu Dhabi, 2017). Providing a legal basis for this, the UAE amended Federal Traffic Law No. (178) in July 2017 and mandated the use of CRS or booster seats for children below the age of 4 years (Department of Health Abu Dhabi, 2018). However, a recent review conducted by Abdullah and colleagues (Abdullah, Mourad, & Muhammad, 2020) concluded that child occupant safety has not significantly improved. In addition, although several promotional campaigns have been launched to improve child occupant safety, there has been limited success mostly likely due to the fact that these campaigns did not consider the societal norms and behaviours regarding restraint use, misuse, and non-use in the UAE (Abdullah et al., 2020).

### **Method**

A survey related to CRS and booster seat use was administered to potential participants in a range of public places in Dubai, including shopping malls, a maternal hospital and customer service centres. Potential participants (both male and female) were randomly approached and were eligible to complete the survey if they were parents/carers of at least one child aged between birth and 10 years.

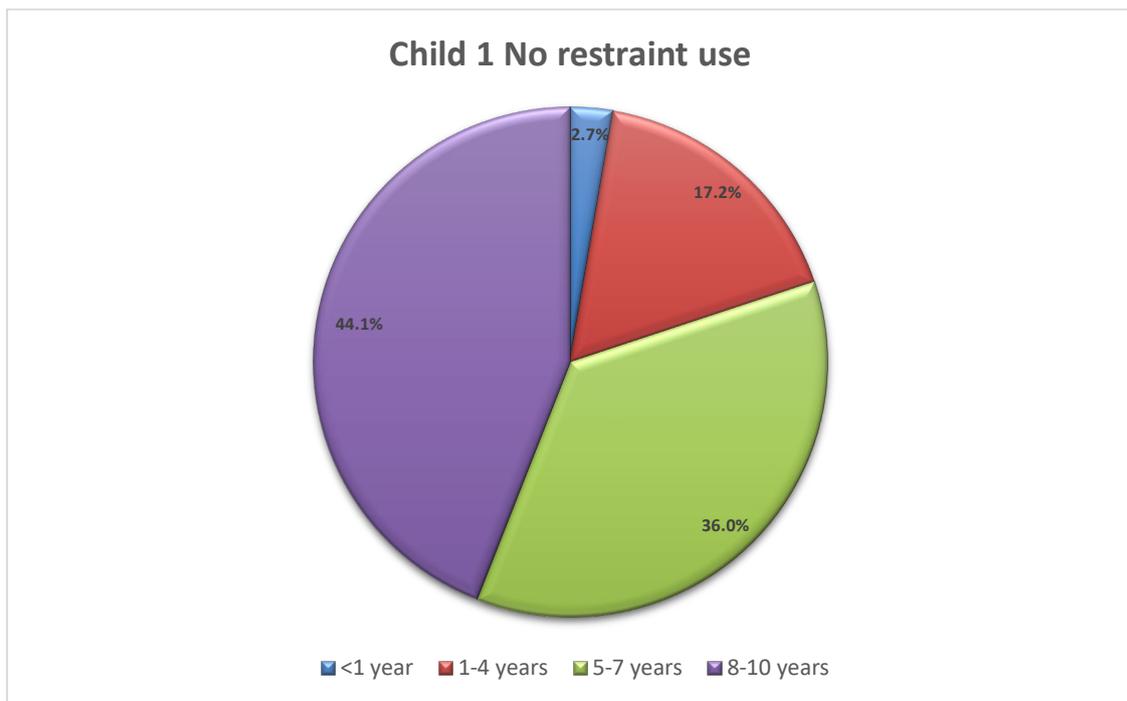
### **Results**

The self-reported survey was completed by 815 parents/carers who were responsible for 1,694 children (aged between birth and 10 years). The participant demographic characteristics are outlined in Table 1.

**Table 1. Participants' demographics characteristics**

		<b>Percentage (n)</b>
<b>Age group</b>	18-25 years	6.6% (54)
	26-35 years	48.3% (394)
	36-49 years	40.0% (326)
	50-74 years	4.9% (40)
	75+ years	0.1% (1)
<b>Gender</b>	Male	41.3% (337)
	Female	56.7% (462)
<b>Education</b>	High School	22.5% (183)
	Undergraduate graduate	67.5% (550)
	Postgraduate (e.g., Masters)	9.1% (74)
<b>Nationality</b>	United Arab Emirates	39.1% (319)
	Other nationalities	60.9 % (496)
<b>UAE Emirate residency</b>	Dubai	78.5% (640)
	Other Emirates	21.5% (175)
<b>Adult seatbelt use</b>	Always	72.0% (587)
	Almost always	13.7% (112)
	Sometimes	10.1% (82)
	Almost never	1.7% (14)
	Never	2.3% (19)

Parents/carers were asked to report the restraint use (i.e., capsule CRS, booster seat, adult seatbelt, or no restraint) for their eldest child (aged 0-10 years) while travelling in a motor vehicle. Overall, 20.6 percent of participants reported that they 'never' restrained their eldest child. It was interesting to note that the proportion of children who were 'never' restrained increased with child age (see Figure 1). These parents/carers were then asked if there was a specific reason for 'never' restraining their child. The most important reason stated for not restraining their child was reported as 'Child's discomfort' (32.1%). Other reasons included 'lack of importance' (6.4%), 'insufficient space' in the vehicle (3.4%), 'nearby destinations' (3.2%), 'too expensive' (1.5%) and 'no legal penalties' (0.5%).



**Figure 1: Proportion of participants who reported that they 'never' restrained their eldest child occupant across age groups**

## Conclusions

This study has made several important findings. Of most concern is the high proportion of child occupants reportedly travelling unrestrained. Parents' knowledge regarding the risks of unrestrained travel, especially for older child occupants (5-10 years) needs to be dramatically improved. The dangers of premature graduation to an adult seatbelt need to be addressed too. Given the predominant role of social media in the UAE, the use of this medium for dissemination of appropriate messages should be explored. Future research is currently being planned to validate the self-reported data in this study with observations of on-road behaviour. These findings will be used identify recommendations that can help to increase correct and appropriate use of CRS, booster seats and adult seat belts for child passengers in Dubai.

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## Road Safety Capability Requirements for Road Authorities

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### Abstract

The Safe System road safety philosophy requires roads to be designed and managed so that death and serious injury are avoidable. The basic principles are: a. Humans are fallible and will inevitably make mistakes. b. Despite this, road trauma is not inevitable. c. To prevent trauma, the road system must be forgiving. Successful road safety requires staff with the appropriate skills in the Safe System (capability), and sufficient numbers of staff to effect noticeable changes (capacity).

Capability development training for lead road safety authorities in Australia, New Zealand and South-East Asia, enabled us to identify those capability areas that need to be strengthened or are particularly effective. This depends on the career phase of the practitioner as well as the particular concerns of their jurisdiction. For example, motorcycle safety is particularly problematic, especially in the Asian region where motorcycles are the predominant mechanised transport mode.

### Background,

An engineer working in a road agency is expected to have knowledge in a broad range of technical areas - everything from designing roads, maintaining, managing assets & traffic. One needs to have basic fundamental understanding of these broad areas from a technical perspective. This paper focusses on technical competencies, in addition there are general competencies such as report writing, communication, time management skills etc., that also need to be acquired. This is a great deal of material to cover so that it is no surprise that there are frequent complaints about skill shortages in these areas.

### Learning Pathways

Formalised road safety education is an important way to provide road managers, designers and engineers with the knowledge required to effect improvements in road safety. The provision of information leads to knowledge, and knowledge will lead to wise practice.

A learning pathway focusing specifically on Road Safety as a disciplinary area has been developed. Because potential participants frequently ask “What courses do I need to go to?”. The pathway has been disaggregated to provide a package of training that suits different phases in a career. We have found that people are unsure as to what training is appropriate to them at their career stage or level of knowledge. In addition, training is often best done by building on earlier training and knowledge.

Table 1 illustrates recommended career-phased road safety learning pathways.

The **graduate phase** focusses on fundamentals type training, as these are the base topics from which to start building technical knowledge in relation to road safety. The **mid-level phase** emphasises design as this is where knowledge is being applied to every-day work. The **established phase** concentrates on leading, evaluating, developing strategy and challenging traditional thinking. People with a wealth of experience, and a back catalogue of previous training seek these advanced training programs to help them in their leadership role. In this phase it's about developing and leading programs and people and about being a road safety leader within a road agency.

These suggestions are based on capability development training for lead road safety authorities in Australia, New Zealand and South-East Asia. However, individuals will determine the pathway most effective for themselves and their circumstances.

**Table 1. Career-phased Road Safety Learning Pathway**

<b>Graduate</b>	<b>Mid-Level</b>	<b>Established</b>
Road Safety Engineering	Safe System Assessments	Road Safety Leadership Program
Road Safety Audits	Road & Public Space Lighting	Crash Investigation and Reconstruction
Traffic Engineering Fundamentals	Intersection Design	Road Strategy and Evaluation
Blackspot Investigation	Roundabout Design	Advanced Road Safety Audit
Geometric Design Fundamentals	Cycling Auditor	Kinetic Energy Management Model
Safe System Principles	Road Safety Barriers	Program Zero
Signs and Lines	Local Area Traffic Management	
Making Roads Motorcycle Friendly	Star Rating Essentials	
Vulnerable Road Users		

**Developing Technical Capability**

The method by which these learning pathways are delivered can vary. Some different ways to develop technical capability are shown in Figure 1. These methods are presented in order of effectiveness, based on our experience, with the effectiveness increasing as one descends the triangle so that the length of the line is an approximate measure of the effectiveness.



**Figure 1. Methods of capability development**

## **The impact of the medium in which feedback is presented on young drivers' speed management behaviour.**

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### **Abstract**

The aim of the present research is to examine the effect of the medium in which feedback is delivered (verbal, written, graphical) on young drivers' speed management behaviour in a 60km/h speed zone, immediately post-training and one week post-training. Sixty young drivers, randomly allocated to one of four feedback groups (i.e., Control, Verbal feedback, Written feedback, and Graphical feedback) completed one training and two test drives using an instrumented vehicle. The results showed that feedback presented graphically was most effective in reducing the mean speed travelled in the 60km/h speed zone. These effects were present immediately following training as well as one week later. These findings have important implications for the development of a new approach to improve young drivers' speed management behaviour.

### **Introduction**

Evidence from numerous studies in both aviation and road has shown the benefits of feedback in improving operators' risk management skills (Molesworth et al., 2006; Molloy et al., 2019). In training, feedback helps calibrate learners' performance, thereby allowing the learner to formulate a plan of action to reduce the gap between their current and expected performance (Boud, 2015). Feedback can be presented through various modalities: *visual* (e.g., written and graphical) and *auditory* (verbal) (Balcazar et al., 1985). Visual feedback can be either textual or graphical/ tabular or a combination. Auditory feedback on the other hand constitutes words or sounds. The literature indicates that feedback involving graphical information is consistently more effective than other mediums in positively influencing behaviour change (Balcazar et al., 1986). However, the effectiveness of the feedback modes varies based on the area of application (Tayebi et al., 2017). The main aim of this research is to investigate the effect of the medium in which feedback is delivered (verbal, written, and graphical) on young drivers' speed management behaviour on the road.

### **Method**

Sixty young drivers (36 males), aged 18 to 25 years ( $M = 20.32$ ,  $SD = 1.89$ ) were recruited for the on-road driving study, conducted over two sessions, spaced one week apart. In session one, participants completed a practice drive, followed by a baseline drive. After the baseline drive, and based on the random group allocation, participants received feedback about their driving performance (speeding behaviour): no feedback (control), verbal feedback (presented verbally), written feedback (presented in a written form), and graphical feedback (presented graphically). The content of the feedback involved an evaluative component of drivers' performance (e.g., number of speed exceedances, maximum speed), as well as financial and safety consequences. All modes of feedback contained the same information and were provided by a researcher verbally, in writing on a piece of paper, and graphically on an electronic device. Immediately following the training/ or in the case of the control group, a five minute break, participants completed a second drive, referred to as the 'immediate post-training drive'. One week post-training, participants completed session 2 of the study, which included a third test drive, referred to as the 'one week post-training drive'.

The experimental design comprised a 4 x 3 mixed repeated measures design. Training was the sole between-groups independent variable, containing four levels: Control, Verbal Feedback, Written Feedback, and Graphical Feedback. The sole repeated measures variable was Time that contained three levels: baseline, immediate post-training, and one week post-training. The mean speed in 60km/h speed zone featured as dependent variable.

## Results

The results of a mixed repeated measures ANOVA revealed a main effect of Training, Time, and Training by Time interaction. Post hoc analysis of Time revealed improvements in performance from pre-training to the two post-training drives. The main effect of Training revealed differences between all groups with feedback compared to Control ( $p < .001$ ; between Control and all other groups). Post hoc analysis for the interaction effects, showed no difference between groups at baseline. The results immediately post-training revealed that mean speed for the Control group was higher compared to Graphical Feedback group ( $p = .017$ , Cohen's  $d = 1.51$ ); and the mean speed for the Graphical Feedback group was lower compared to all other groups one week post-training ( $p = .039$ , Cohen's  $d = 1.89$ ).

## Discussion

These results illustrate the positive effect of graphical feedback, in terms of improving young drivers' speed management behaviour. The benefits of graphical feedback over other mediums of feedback may be due to its visual cues and factual clarity (Mayer, 2001). While the exact reason why graphical feedback was most effective is unknown, these results have important implications for the development of a new approach to improve young drivers' speed management behaviour.

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## **Driving Safer Rural Roads – A systematic safe system review of a local government rural road network**

Kate McDougall<sup>a</sup>, Aaron Dunn<sup>b</sup>,

<sup>a</sup>Eurobodalla Shire Council 1 & 2,

### **Abstract**

Eurobodalla Shire Council (ESC) is working towards achieving zero deaths on their local road network through commitment of safe system approaches including building network capacity and implementing safety improvements. In 2019, ESC select road management staff inspected all 280km of rural and regional sealed roads, systematically documenting 911 identified road safety issues. The resultant Road Safety Review integrated into the Eurobodalla Road Safety Plan 2019-2021 (RSP) ensures ESC's whole of network and route approach targets high priority actions addressing funding of hazard elimination, prioritizing road maintenance, while promoting ESC staff to train others in identifying and reporting hazards.

### **Background**

ESC has 280km of rural and regional sealed roads. ESC have been working towards reducing the unacceptable level of road related trauma on local rural roads using the four pillars of the Safe System. Of the 728 injury crashes 2011-2017 in the Eurobodalla, 376 occurred on local, regional and other roads, 152 or 46.9% of these occurred on 9% of the ESC network, being the busier regional and distributor road.

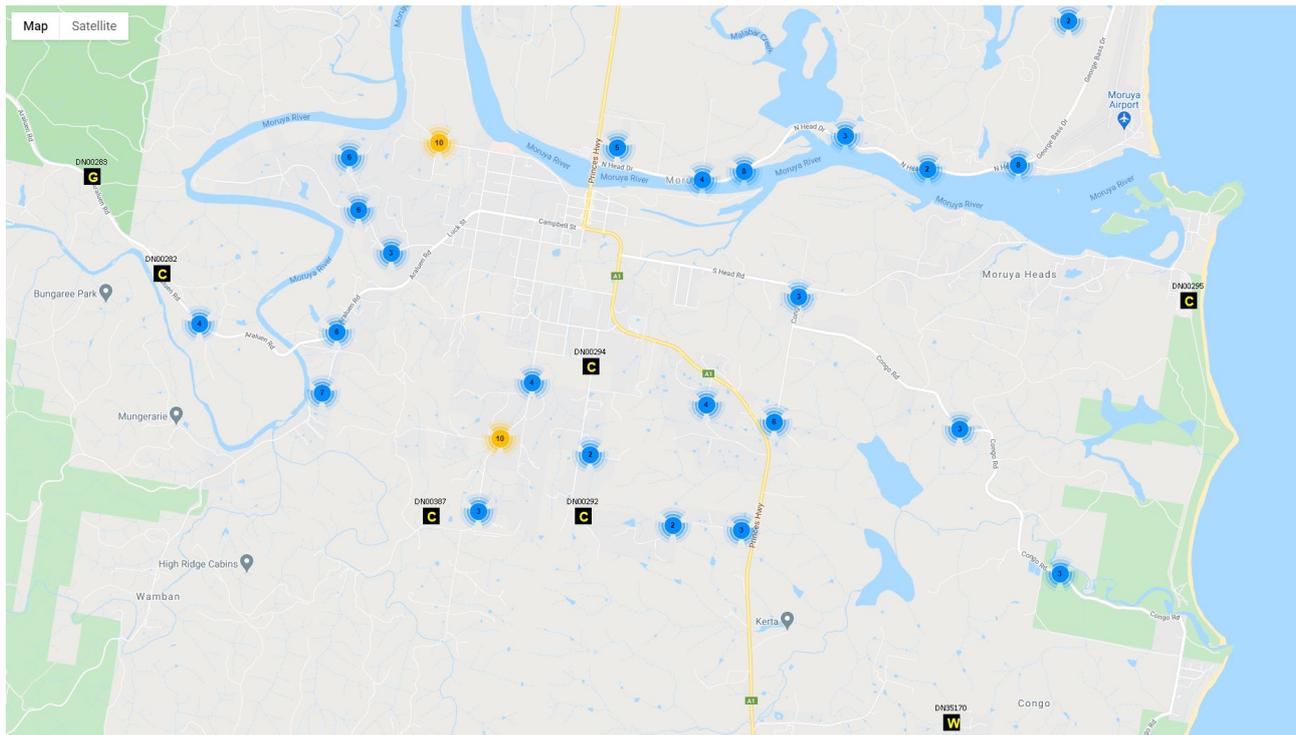
### **Summary of methodology**

ESC proactively adopted an approach to improve road safety and network operation by conducting a systematic assessment of road safety hazards on sealed rural roads. From January to May 2019, six ESC Road Safety Audit (RSA) trained staff were paired with ESC Asset Inspectors, drove all rural and regional sealed roads identifying and electronically documenting road safety issues. ESC adapted REFLECT maintenance software to electronically document identified road safety issues, including hazard location, type and preliminary assessment of potential treatment.

Key road features targeted in the inspections were:

- Roadside clearzone hazards (eg culvert headwalls, unprotected drop-offs, and trees)
- Guardrail/protective fencing
- Lane/shoulder width
- Road geometry
- Sight lines at intersections & major driveways
- Advisory speed & warning signage

Field data was supplemented with additional information including crash history, speed zone, traffic volume, preliminary treatment options, costs estimates, and preparatory planning work required. Each road safety issue has been documented with an individual site report.



**Figure 1: Identified road safety hazard locations as identified and documented in REFLECT**

## A summary of the findings

By concentrating on the roads pillar of the Safe System the review identified 911 road safety issues on ESC's rural and regional sealed road network as categorised in Table 1.

Reviewing ESC's road network, 123 identified hazards were located on regional roads, 102 on distributor roads, 241 on collector roads with remainder on local roads where 376 or 51.4% of casualty crashes 2011-2017.

Of those hazards identified 55% of the issues were in the northern parts of the Shire where 36% of all crashes 2011-2017 occur on four local and regional roads.

## Where to from here

The review has been integrated in ESC RSP (p34, 6.1.12) to ensure Council's activities target high priority actions. Identified hazards will be prioritised with preliminary issues addressed and initial site works scoped and costed for funding availability. The prioritisation will adopt a holistic approach focusing on route and network outcome integrated solutions with improved short and long term results.

ESC has achieved multiple benefits from the review including technical staff gaining experience and awareness of road safety for their network. The results summarised the necessary data to enable road safety to be equally considered by Council when prioritising road maintenance. The review also enables road safety to be integrated into Council's annual budget and operational plans.

However, due to the severity of the 2019/2020 summer bushfires on the Eurobodalla road network, the review findings required reprioritisation. Many original identified low risk clear zone hazards, namely vegetation, have been addressed due to fire damage and increased risk. The review allows for adaptability in delivery of the RSP through the priority actions of each issue type.

<b>Issue Type</b>	<b>Number</b>
Road alignment	24
Batter slope hazards	55
Clear zone hazards – primarily vegetation – trees, bushes and grasses	446
Guardrail – lack of guardrail	79
Signs and Linemarking	36
Pavement hazards	44
Sight distance	50
Drain/Table drain	120
Lane/Shoulder width	57

**Table 1: Summary of road safety issues**

## References

[Eurobodalla-Road-Safety-Plan-2019-2022.pdf \(nsw.gov.au\)](#)

## Safe Systems Review of Fatal and Serious Injury Crashes in Sydney

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<sup>a</sup>Transport for New South Wales

### Abstract

The Safe System approach involves different elements of the system working together to help eliminate fatality and serious injury. This study reviewed 14,064 fatal and serious injury (FSI) crashes that occurred in Sydney during the five year period from 1 January 2014 to 31 December 2018. The analysis was conducted using descriptive analysis and the chi-square test. The review identified common FSI crash factors across Safe System pillars (roads, speed, vehicles, people) based on crash data. Results showed that road surface condition, type of location, speeding, age of pedestrian, and license status were the common factors that affected the FSI outcomes.

### Background

Hodgson, McTiernan, Imants & Chevalier (2019) reviewed crashes in the Australian Capital Territory using the Safe Systems approach. The study covered 114 fatal crashes and did not consider serious injury crashes. Furthermore, a literature review identified no studies that investigate both fatal and serious injury crashes across the Safe System pillars. This gap indicates a key need to further analyse the FSI crashes in Sydney using the Safe Systems approach.

Key aims of the study were to:

- Identify factors that contributed to cause and severity of FSI crashes broken down by Safe System pillars (roads, speeds, vehicles, people)
- Analyse the results of the Safe System review of Sydney FSI crashes to inform the development of potential countermeasures, including infrastructure, speed zone review, road user education, and possible policy considerations.

### Method

The data analysed relate to 481 fatal and 13,583 serious injury crashes that occurred in Sydney between 1 January 2014 and 31 December 2018. The data was extracted from Crashlink, the road crash database owned and administered by Transport for NSW. The crash data were reviewed by a team of road safety experts and data analysts to identify causal and severity factors contributing to each crash. These factors were categorised according to the Safe System pillars.

The analyses involved identification of key factors associated with FSIs:

- within each safe systems pillar to determine the common crash factors across the data set
- cross-tabulating various pillars to identify additional trends and links between pillars
- identify typical FSI crash profiles for each Safe System crash type.

A statistical-descriptive analysis of the crash characteristics was carried out. For continuous variables, for example, sample size, percentage, mean, median, standard deviation and range were estimated. For categorical variables, frequency and percentage were estimated.

Chi-square test is used to test if there is any difference between crash severities (eg. Fatal vs. Serious Injury crashes) and casual, behavioural and contributing factors (eg. type of locations, speeding involved, age group etc.) across the Safe System pillars. The null hypothesis is that crash severity is independent of the casual, behavioural and contributing factors.

Countermeasures were developed from the analysed results to address the identified Safe System gaps.

## Results / Recommendations

The five highest crash types in terms of number of fatal and serious injury crashes on all Sydney roads is shown in the Table 1. Table 1 also provides potential countermeasures for each crash types.

Approximately 15% of fatal crashes and 30% of serious injury crashes were considered atypical, and analysis did not reveal any patterns or trends within these crashes across the Safe System pillars.

**Table 1. Safe System review of FSI crashes and examples of potential countermeasures for consideration for typical crash profiles**

Crash type	Crash severity (%)	Examples of potential countermeasures for consideration
<b>Pedestrian</b>	Fatal: 37.8% Serious Injury: 16.7%	<ul style="list-style-type: none"> <li>• Reduce speed limit to 30 km/h in areas with high-pedestrian activity</li> <li>• Physical separation / segregation (foot path, shared paths, crossing point)</li> </ul>
<b>Off road</b>	Fatal: 27.2% Serious Injury: 24.5%	<ul style="list-style-type: none"> <li>• Speed Zone Reductions</li> <li>• Vehicle activated signs</li> <li>• Installing safety barrier, shoulder widening</li> <li>• Audio tactile line marking (ATLM), delineation devices (RRPMs, guide posts)</li> </ul>
<b>Head on</b>	Fatal: 10.2% Serious Injury: 4.4%	<ul style="list-style-type: none"> <li>• One way traffic</li> <li>• Wire rope/concrete median barrier</li> <li>• Wide centreline treatment (ATLM), wide median</li> </ul>
<b>Rear end</b>	Fatal: 5.6% Serious Injury: 11.7%	<ul style="list-style-type: none"> <li>• Speed Zone Reductions</li> <li>• Turning restrictions (No Right Turn), dedicated turn lanes</li> <li>• Enhancing traffic signals, installing advanced warning on approach to rear end crash clusters etc.</li> <li>• Upgrade pavement to high friction seal</li> </ul>
<b>Right through</b>	Fatal: 3.5% Serious Injury: 11.6%	<ul style="list-style-type: none"> <li>• Installing roundabouts</li> <li>• Removing filter turns from traffic signals</li> <li>• Turning restrictions (No Right Turn) , dedicated turn lanes</li> <li>• Speed Zone Reductions</li> </ul>

Other common factors identified across various crash types include:

- Older pedestrians overrepresented in pedestrian fatalities compared to other age groups
- Increased severity for crashes where road users exceed safe speed for the road environment
- The number of young male drivers involved in off road crashes compared to other gender and age groups
- Drivers' use of drugs and/or alcohol
- T-intersections have seen 24.7% of fatal crashes and 28.3% of serious injury crashes.

## References

Hodgson, G., McTiernan, D., Imants, P., Chevalier, A., 2019. Safe System Review of Fatal Crashes in the ACT. Australasian Road Safety Conference, Adelaide, Australia.

## **Road Trauma Support WA: Using a Public Health Approach to reduce the long term effects of road trauma**

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<sup>a</sup>Injury Matters

### **Abstract**

Injury Matters provides Road Trauma Support WA (RTS WA), a state-wide service assisting anyone affected by road trauma, regardless of when the incident occurred, or the person's level of involvement. The purpose of this project is to share evaluation findings of applying a public health approach to RTS WA and to inform the service to meet the need of people impacted by road trauma. In 2018, a comprehensive evaluation framework was developed and implemented to show the impact of the service. The annual survey findings indicated 78.73% (n=37) of counselling clients incorporated topics that were discussed into their everyday life. Whilst service users have engaged with RTS WA for a specified road incident, the service often identifies complexities and underlying mental health concerns. This is addressed through a public health approach to support prevention strategies, as well as intervention strategies for those impacted by road trauma.

### **Background**

In 2018, 161 people died on WA roads, with the impact of a crash felt long after the scene is cleared and the ripple effect impacting on people in different ways (Craig et al., 2016; Road Safety Commission WA, 2018). To support those impacted by road trauma, Injury Matters provides Road Trauma Support WA (RTS WA), a state-wide service assisting anyone affected by road trauma, regardless of when the incident occurred, or the person's level of involvement.

The RTS WA service utilises a public health approach for supporting clients with recovery and preventative strategies for optimal health and wellbeing. Since November 2013, RTS WA has provided information, support, training, and specialised trauma and bereavement counselling to reduce ongoing psychological and social distress of people affected by road trauma.

### **Purpose of Project**

The purpose of this project is to share evaluation findings of applying a public health approach to RTS WA and how it informs the service to best meet the need of people impacted by road trauma.

### **Project Methods**

In 2018, Injury Matters developed and implemented a comprehensive evaluation framework to show the impact of the service. Ongoing process data collection included number of counselling sessions and contacts, client wellbeing (MyOutcomes software), workshop attendance, enquiries, referrals, and resource access.

An annual survey was developed and implemented with people that engaged in the service through enquiries, workshops and presentations, counselling sessions and resources. The survey tool included questions relating to the following domains; engagement, knowledge, satisfaction and behaviour change. Results were analysed and reported as frequencies using *jamovi* (Version 0.9) data analysis software. Open-ended responses were analysed and reported through themes.

## Evaluation

Since its establishment in 2013, RTS WA has provided specialised counselling to 1,159 individuals, delivered 2,530 counselling contacts, responded to over 1,000 requests for information and resources from individuals and organisations. The MyOutcomes data highlighted dual-complexities with other psychological issues.

Annual survey evaluation findings (n = 61) who engaged with RTS WA activities indicated 83% (n=51) of respondents contacted RTS WA following a road traffic incident; 63% reached out within 12 weeks of their road incident; and 78.73% (n=37) incorporated topics that were discussed in the counselling session into their everyday life. Qualitative feedback showed the need for follow-up consultations, possibility to target other industries including schools and regional areas, and appreciation for the creation of a safe space to grieve.

## Conclusions

The evaluation of RTS WA has shown areas of success and informed future work, including the need for varying levels of support for clients. Whilst service users have engaged with RTS WA for a specified road incident, the service often identifies complexities and underlying mental health concerns. This is addressed through a public health approach to support those impacted, as well as identify areas for prevention. RTS WA provides support strategies to reduce ongoing psychological and social distress of people affected by road trauma. This contributes to improved wellbeing and quality of life and reduced impact on health resources from adverse psychosocial outcomes, including hospitalisation.

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## The CITI connected light vehicle study: lessons learnt

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<sup>a</sup>ARRB (Australian Road Research Board), <sup>b</sup>Centre for Road Safety, Transport for NSW, <sup>c</sup>Austrroads

### Abstract

The Cooperative Intelligent Transport Initiative (CITI) aims to investigate the safety benefits, acceptance, and issues surrounding deployment of cooperative intelligent transport systems (C-ITS). As part of CITI, members of the public consented to participating in a field operational test (FOT) which involved fitting C-ITS technology to their light vehicle for approximately 10 months. Members of the research team provided input on lessons learnt from the FOT which were summarised into issues, future actions, and what was done well. Strengths of the FOT related to achieving the aim to capture findings to inform considerations about wider roll out of C-ITS. Other strengths related to the training and equipment installation and maintenance processes. Known limitations of the FOT included the sample size being insufficient to investigate the safety benefits of C-ITS. Suggestions to address this included a trial with a larger participant sample size, and increasing the amount and types of equipped infrastructure and alerts. Key lessons learnt relate to improvements to the human-machine interface, technology configuration, and data capture. It is envisaged these lessons will assist developers and researchers undertaking trials of similar technologies.

### Background

C-ITS has the potential to reduce fatal and injury crashes, as this technology can ‘see’ around corners and through obstructions blinding drivers to the road ahead. This Australian-first FOT aimed to increase understanding of the public acceptance, safety benefits and limitations of C-ITS. The purpose of the FOT review was to capture lessons learnt during and as an outcome of the FOT, explore how challenges could be addressed another time, and identify what aspects of the FOT worked well.

CITI was established by Transport for NSW (TfNSW) in 2012 to investigate the safety benefits, user acceptance, and issues surrounding wider deployment of C-ITS technology. Up to 60 trucks, 11 public buses, two light fleet vehicles, one fleet motorcycle and three signalised junctions operated within the C-ITS testbed. The C-ITS basic safety messages (BSMs) are transmitted and received at 10Hz, between within-range, equipped vehicles and traffic signals, over a dedicated radio frequency within the geofenced-testbed, between Sydney and Kiama. As part of CITI Stage 2, 55 members of the public consented to having their light vehicles fitted with C-ITS which provide safety alerts and telematics technology which included an accelerometer and recorded driving data at 40Hz.

Participant vehicles were fitted for approximately 10 months, including a baseline period (approx. 5 months) without active alerts and a treatment period (approx. 5 months). The FOT included three types of alerts:

- Red traffic light warnings (vehicle-to-infrastructure (V2I))
- Intersection collision warnings (vehicle-to-vehicle (V2V))
- Harsh braking ahead warnings (V2V)

The in-vehicle equipment collected data including C-ITS generated alerts, accelerometer data, and GPS based location and speed data. Participant pre-driving data collection included demographic information, risk perception and self-reported driving behaviour. Following the driving component of the FOT, participants completed surveys about their experience with the C-ITS. A subset of pre-

selected participants also completed a focus group or phone interview about the technology and their experience in the FOT.

Participants' mean age was 49.4 years (SD=10.72), and 52.7% (29/55) were males. In-vehicle data were collected from 49 participant vehicles, and 45 participants completed all aspects of the FOT. Data collection was completed in July 2019.

## Method

To identify the lessons learnt, we sought input from members of the research team from TfNSW and the Australian Road Research Board (ARRB) and reviewed participant feedback from surveys, focus groups and interviews to ensure lessons were captured from each stage of the FOT. This input was consolidated within a report which summarised each issue, what was done well, and suggested future actions.

## Results

Key lessons learnt cover strengths, challenges and suggested improvements to the FOT. The strengths of the FOT include:

- Results of the surveys, focus groups and interviews enabled TfNSW to gain meaningful insights into participants' experiences with, perceptions of, and suggestions regarding the C-ITS technology and concepts related to wider implementation of C-ITS.
- Undertaking the lessons learnt review enabled TfNSW to gain insights into the kinds of challenges involved in wider implementation of C-ITS and ways to address these challenges.
- Participants provided positive feedback about the information and training provided to them.
- Efficient and effective equipment installation, removal and maintenance processes.

A known limitation of the FOT related to the inability to assess the safety benefits of the technology. Suggested improvements to enable better investigation of the safety benefits of C-ITS include undertaking a larger trial (based on proof-of-concept tested data collection and analysis methods) by recruiting a larger sample size, employing a longer timeframe of data collection, and/or utilising additional equipped infrastructure and types of alerts.

Challenges associated with the FOT and suggested improvements include:

- Participant feedback about the human-machine interface of the technology, including the display volume and brightness controls, and maintenance issues with the display screen revealed issues which may have affected participants' experience of the technology and alerts. Suggested improvements include greater ability to adjust alert volume and brightness, and use of stronger display mounts.
- There was participant attrition early in the FOT (related to incompatibility between vehicles and the FOT hardware), and some data loss (related to hardware issues). Suggested improvements to maximise data collection include changes to the design and configuration of the installation box and cable design to allow greater flexibility in installation options across vehicle types, and remote in-vehicle equipment health checks and data transmission to monitor and collect data at greater frequency.
- The Red Light Warnings were issued regardless of the vehicle's direction of travel (i.e., an alert for a red straight through movement would also be issued to a driver turning with a green arrow). Due to lack of availability of traffic signal phase and timing (SPaT) data, analyses could not be undertaken to test the safety benefits of these alerts. Suggestions to enable this analysis include changes to the design of the traffic signal alerts and/or capture of SPaT data.

## **Conclusion**

Lessons learnt from this FOT may be of assistance to those developing C-ITS technology or undertaking current or future trials of C-ITS or similar technologies.

## The next frontier: Road safety in the workplace

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Transport for NSW

### Abstract

In NSW, around one in three workplace fatalities occur while driving or riding for work. It is the number one cause of death in the workplace and for many employers it is their greatest workplace risk. Under the *Work Health and Safety Act (2011)*, all employers in NSW have an obligation to ensure their workers have a safe place to work. Transport for NSW has developed a suite of resources to help employers embed a positive road safety culture in their workplace, with the aim of highlighting the significance of the risk while creating an ethos of shared responsibility.

### Background

Data suggests approximately 35% of workplace fatalities are a result of a road crash (Safe Work Australia, 2020). To put this into context, NSW crash data shows that around 26% of fatalities each year on NSW roads are from crashes involving a vehicle being used for work (NSW Centre for Road Safety, 2016-2019 average).

### Training workshops and employer engagement

Transport for NSW, in collaboration with the State Insurance Regulatory Authority, has developed resources that aim to help employers address their road safety risk, and to also provide support and guidance as they embark on their road safety journey. Training materials were created and workshops held with regional Transport for NSW and local government staff in a train-the-trainer model to assist with broad state-wide coverage within their local areas. These resources include:

1. Road Safety and Your Work: A Guide for Employers
2. Road safety in your workplace fact sheet
3. Guidance on developing a road safety policy
4. Presentation to deliver to employers
5. Short and practical employer conversations.

Together these resources have been disseminated to a large number of employers throughout NSW, with many small, medium and large employers engaging about their road safety needs. Transport for NSW is providing these employers with assistance in developing their own internal road safety policies with the goal of firmly embedding these practices.

### What's next?

Over the coming months Transport for NSW will be releasing interactive, engaging and thought-provoking digital resources to further equip employers. This includes:

#### *A digital learning solution*

Transport for NSW, icare and Western NSW Local Health District have identified that there is a gap in workplace safety of providing information direct to workers. To address this, all three organisations are working together to develop a highly-interactive, engaging, and stimulating digital learning solution targeting workers that drive in regional areas, undertake long-distance trips, or drive regularly for work. This resource will be available to NSW Government workers and made publicly available through a new, dedicated website housing a suite of new resources for both employers and workers.

### *Case studies*

Transport for NSW will be releasing several case studies to showcase to employers what is considered best practice. These videos provide information, tips, tools and support for employers to implement similar ideas and practices whilst outlining the journey the business has undertaken.

### *Partnerships*

Transport for NSW is also partnering with government and non-government organisations to further spread the safe workplace messages. Our ultimate goal is that every workplace in NSW will be aware of their road safety risk and appropriately managing the risk to themselves and their workers.

### **Conclusion**

Together, these resources and Transport for NSW's engagement activities are delivering our commitment under the *Road Safety Plan 2021* to enhance communications, initiatives and tools to help employers and industry embed a road safety culture, especially for work-related journeys and high risk shift workers.

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- NSW Centre for Road Safety. (2020). *Road Safety and Your Work: A Guide for Employers*. Transport for NSW <https://roadsafety.transport.nsw.gov.au/downloads/road-safety-and-your-work.pdf>

In NSW, around one in three\* workplace fatalities occur while driving or riding for work. It is the number one cause of death in the workplace and for many employers it is their greatest workplace risk. Under the Work Health and Safety Act 2011 (NSW), all employers in NSW have an obligation to ensure their workers have a safe place to work. Transport for NSW has developed a suite of resources to help employers embed a positive road safety culture in their workplace, with the aim of highlighting the significance of the risk while creating an ethos of shared responsibility.

#### Background

Data suggests approximately 35% of workplace fatalities are a result of a road crash (Safe Work Australia, 2020). To put this into context, NSW crash data shows that around 26% of fatalities each year on NSW roads are from crashes involving a vehicle being used for work (NSW Centre for Road Safety, 2016-2019 average).

#### What's next?

Transport for NSW has recently released interactive, engaging and thought-provoking digital resources to further equip employers. This includes:

#### Online learning tool

Transport for NSW, icare and Western NSW Local Health District have identified that there was a gap in workplace safety of providing information direct to workers. To address this, all three organisations worked together to develop a highly-interactive, engaging, and stimulating digital learning solution targeting workers that drive in regional areas, undertake long-distance trips, or drive regularly for work. This resource will be available to NSW Government workers and is currently publicly available through a new, dedicated website housing a suite of new resources for both employers and workers.

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Transport for NSW has released several case studies to showcase to employers what is considered best practice. These videos provide information, tips, tools and support for employers to implement similar ideas and practices while outlining the journey the business has taken.

#### Partnerships

Transport for NSW is continuing to partner with government and non-government organisations to further spread these safe workplace messages. Our ultimate goal is that every workplace in NSW will be aware of their road safety risk and appropriately managing the risk to themselves and their workers.

For more information, visit [towardszero.nsw.gov.au/workplace](https://towardszero.nsw.gov.au/workplace)

**NUMBER 1**  
CAUSE OF DEATH  
IN THE WORKPLACE

**1 IN 3\***  
WORKPLACE  
FATALITIES  
OCCUR WHILE  
DRIVING/RIDING  
FOR WORK

**ROAD SAFETY  
IN THE  
WORK-  
PLACE**

TOWARDS ZERO

**TRANSPORT  
FOR NSW**  
HAS DEVELOPED  
RESOURCES TO HELP  
EMPLOYERS ADDRESS  
ROAD SAFETY RISK

1

**ROAD SAFETY AND YOUR WORK:  
A GUIDE FOR EMPLOYERS**

2

**ROAD SAFETY:  
EVERYBODY'S BUSINESS  
ONLINE LEARNING TOOL**

3

**GUIDANCE ON  
DEVELOPING A  
ROAD SAFETY  
POLICY**

4

**ONLINE  
TOOLKIT  
FEATURING  
FACT SHEETS,  
TEMPLATES,  
CHECKLISTS,  
CASE STUDIES  
AND MORE**

5

**ENGAGING  
GOVERNMENT AND  
NON-GOVERNMENT  
ORGANISATIONS TO  
DRIVE PROGRAM  
UPTAKE**

## Making nighttime pedestrians safer using innovative clothing designs

Joanne M. Wood,<sup>a</sup> Dean Brough<sup>b</sup>, Mark King<sup>c</sup>, Neil King<sup>d</sup>, Laura A. Bentley<sup>a</sup>, Fiona Fylan<sup>e</sup>, Alex A. Black<sup>a</sup>

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### Abstract

Nighttime pedestrians are at significant risk of being killed or seriously injured, because drivers often fail to see them in time to avoid a collision. Clothing incorporating retroreflective markers on the moveable joints creates a visual perception of ‘biomotion’ and improves nighttime pedestrian conspicuity. This study investigated whether biomotion-enhanced clothing retains its conspicuity if adapted to make it more acceptable to wear. In a nighttime closed road study, we compared the relative conspicuity of pedestrians to young drivers with normal vision when pedestrians wore biomotion strips of different thicknesses and patterns, versus other typical clothing worn by nighttime pedestrians. Results showed that all the biomotion clothing resulted in significantly longer conspicuity distances than sports, fluorescent yellow or black clothing (4x longer distances than black clothing). These effects were evident regardless of pedestrian orientation and have implications for the design of clothing for walkers and runners to enhance their nighttime safety.

### Background

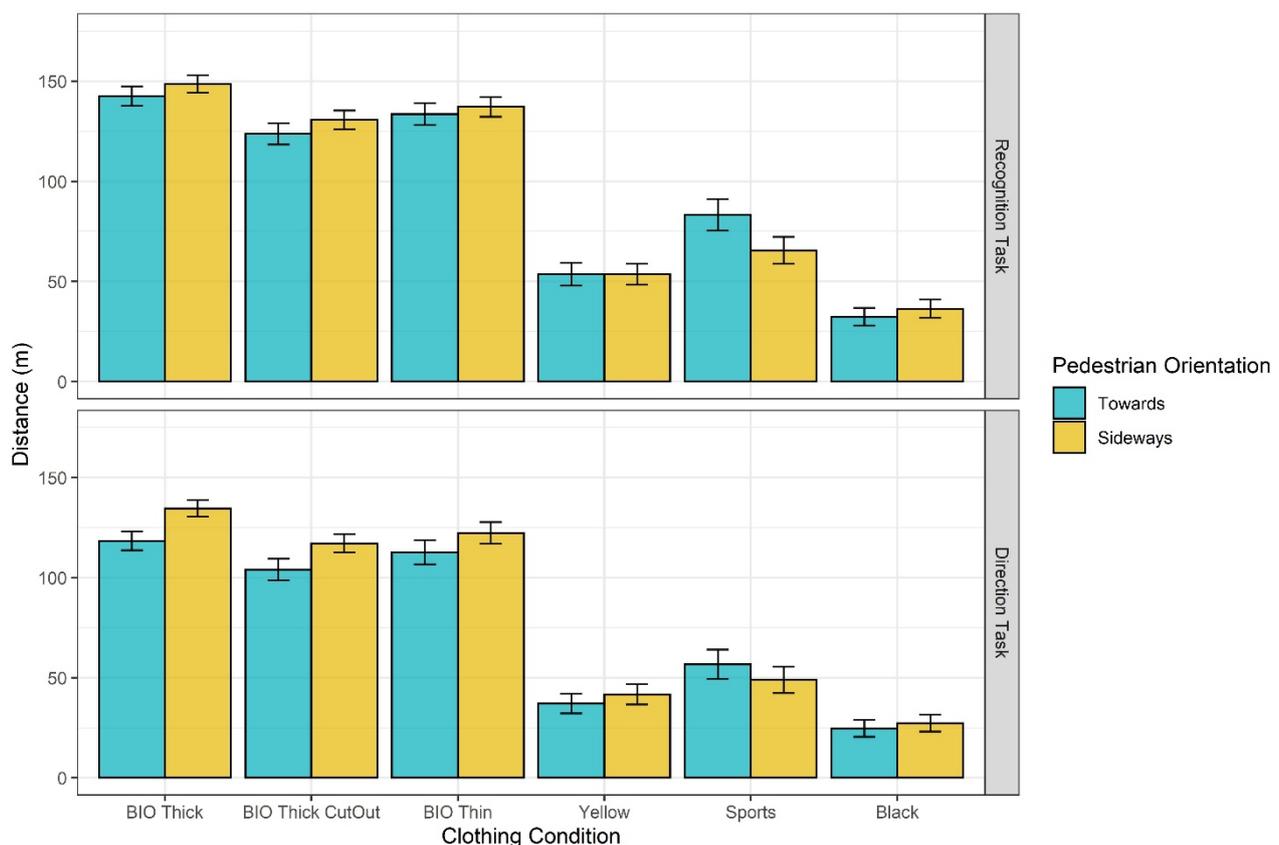
Fatality rates for pedestrians are up to seven times higher at night than in the day (Sullivan & Flannagan, 2007). While there are many contributing factors, reduced visibility is the most important, where drivers commonly fail to see pedestrians in time to avoid a collision. Research has demonstrated that clothing incorporating retroreflective material on the moveable joints (wrists, elbows, ankles, knees) improves nighttime pedestrian conspicuity by creating the perception of ‘biomotion’ for drivers (Wood, 2020). Importantly, most nighttime pedestrian studies have incorporated retroreflective strips in roadworker-type outfits, which are less appealing to wear for recreational pedestrians and runners. We explored whether biomotion clothing could be made more appealing, by reducing the width of the retroreflective strips, while still retaining high conspicuity.

### Method

Nighttime pedestrian recognition was measured for 14 visually normal, young participants (mean age  $24.3 \pm 3.1$  years), while they drove an instrumented vehicle around a closed-road circuit. Two pedestrians walked in place at the roadside at different locations, for two different orientations: facing towards, or sideways to the oncoming vehicle. For each lap, pedestrians wore one of six clothing conditions: three biomotion configurations with retroreflective strips 0.75cm wide (thin solid), 1.5 cm wide (thick solid) or 1.5 cm shaped (thick cut-out), as well as conditions with black leggings with either a black top (black), or a fluorescent yellow top, and one commercially-available nighttime sports outfit containing retroreflective material; the order of clothing condition was randomised. Drivers tapped a response pad when they first recognised a pedestrian was present (detection task) and a second time when they identified their walking direction (direction task: towards or sideways).

## Results

Overall, distances for the pedestrian recognition task were longer than for the detection of direction task ( $p < 0.001$ ). For the recognition task, clothing had a significant effect on recognition distances ( $p < 0.001$ ), where all the biomotion clothing resulted in significantly longer distances than sports, yellow or black clothing (Figure 1). Overall, pedestrians wearing biomotion strips were recognised earlier, at four times longer distances compared to when wearing black. There was no significant effect of pedestrian orientation on recognition distance ( $p = 0.84$ ), but there was a significant interaction of clothing and orientation ( $p = 0.034$ ), where sports clothing was less effective when pedestrians walked sideways than towards oncoming traffic. For the pedestrian direction task, clothing had a significant effect on direction detection distances ( $p < 0.001$ ), where all the biomotion clothing resulted in significantly longer direction detection distances than sports, yellow or black clothing (Figure 1). There was a significant effect of pedestrian orientation on direction detection distance ( $p = 0.004$ ), and a significant interaction between clothing and orientation ( $p = 0.032$ ), where direction detection distances were longer in the biomotion clothing condition when pedestrians walked sideways than towards the driver.



**Figure 1. Pedestrian recognition and direction detection distances, as a function of clothing condition and pedestrian orientation.**

## Conclusion

Clothing incorporating retroreflective strips in a biomotion configuration, even for the thinnest strip width (0.75 cm) which can be easily incorporated into clothing, significantly improved nighttime conspicuity. These effects were evident regardless of pedestrian orientation and have significant implications for better design of clothing for walkers and runners to enhance their safety on nighttime roads.

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## **Development and Implementation of New South Wales Drink and Drug Driving Reforms**

Louise Higgins-Whitton, Kirsten Sterling, Claire Murdoch, Antonietta Cavallo

Centre for Road Safety, Transport for NSW

### **Abstract**

In 2018/2019, NSW introduced enhanced penalties for drink and drug-driving offenders. The reforms expanded alcohol interlock requirements to middle range offenders, vehicle sanctions to certain repeat drink drivers, and introduced penalty notices coupled with automatic licence suspension for lower range offences.

Key implementation challenges included responding to mixed stakeholder views, managing change across agencies, and providing effective communications. Complementing the reforms, offender rehabilitation courses in NSW are being reviewed to expand reach to more offenders. The number of roadside alcohol and drug tests is also increasing.

A multi-stage evaluation is planned, with an operational review due late 2020.

### **Background**

NSW has been at the forefront of policy changes that contributed to achievements in reducing impaired driving; however drink and drug-driving remains a challenge. In 2018, 64 lives were lost on NSW roads in alcohol related crashes. A similar number of people died in crashes involving a driver or rider with an illicit drug in their system.

### ***Road Safety Plan 2021***

In 2018, the NSW Government announced the Road Safety Plan 2021 (the Plan) to deliver on a 30 percent reduction in road fatalities by 2021.

Key NSW trauma trends, current state and effective countermeasures were reviewed to inform community consultation and actions. The process identified more extensive use of alcohol interlocks, vehicle sanctions, as well as systematic and timely licence sanction for all offences as effective measures to address impaired driving, coupled with enhanced enforcement and education.

### ***Opportunity to enhance the penalty framework***

Prior to the Plan, NSW had significant penalties in place to deter impaired driving, including a Mandatory Alcohol Interlock Program (MAIP) for repeat and high range drink-drivers and automatic licence disqualification on conviction for drink and drug-driving offences.

Immediate licence suspension applied for middle and high range drink driving, and all drink and drug drivers were required to attend court to have their offence determined. On average, the time between arrest and a court determination for a low-range first offence was 44 days. During this time, the offender retained their licence and more than half of all offenders were not convicted, meaning that licence sanction was avoided.

### ***Legislative reform***

As part of the Plan, the NSW Government committed to increase enforcement, but also to strengthen the offender framework through:

- Introducing penalty notices and automatic three month licence suspension in lieu of court attendance for lower range drink-driving and drug-driving first offenders. In the case of drink-driving, suspension is immediate at the roadside.
- Expanding the MAIP to apply to all middle-range drink-driving offenders.
- Enabling roadside vehicle sanctions to be applied by Police in the case of repeat, high-risk drink-driving; extending their application from excessive speeding and street racing type offences.

Further work is also underway to review requirements for offenders to complete an impaired driving rehabilitation course.

### ***Implementation***

The reforms were reviewed by the NSW Legislative Council in a public inquiry, enabling input from key stakeholders and generating media engagement. Stakeholder feedback included concerns about removing lower range offences from the traditional court process and highlighted the need for clear information to the community about the changes.

To enable effective delivery, a strong partnership was formed across relevant agencies (including Justice, the NSW Police Force, and Revenue NSW) to manage operational changes, communications and development of an evaluation framework. Significant public education was delivered at each phase, as well as targeted communication resources for the Aboriginal community.

### **Next Steps**

An operational review is underway of the first 12 months the reforms have been fully implemented. The review will assess the extent to which the reforms have been implemented as planned, and any unintended consequences.

## **Can I Stop? Considering any opportunity to influence the multidisciplinary factors that result in a crash.**

Hendrik Zurlinden<sup>a</sup>, Elizabeth Hovenden<sup>a</sup>, John Gaffney<sup>a</sup>

<sup>a</sup>Department of Transport (VicRoads), Victoria, Australia

### **Abstract**

While over recent decades significant gains have been made in reducing the number of road traffic related fatalities in Victoria and Australia, in absolute terms this has started plateauing some years ago. This contrasts with the ambitious goal to achieve (close to) zero fatalities. The need for a significant change in road safety management has been identified (Wooley & Crozier, 2018). Based on insights gained during practical road traffic management, a study tour of nine countries (Gaffney, 2016), and a very comprehensive literature analysis, many opportunities to strengthen the current road safety work were identified. This includes an increased, vehicle-centred focus on crash avoidance, the reduction of traffic complexity and mental workload, the provision of targeted dynamic information of inclement weather and traffic conditions, and an integrated emergency response.

This article aims at stimulating broad discussions among road safety experts for the development of next-generation road safety strategies.

### **Background**

Road safety gains in absolute terms have started plateauing some years ago (refer to Figure 1a). What is equally, if not more concerning is the recorded and predicted increase in road-crash related hospitalisations (refer to Figure 1b, included in BITRE, 2018). The above trends contrast with the ambitious goal to achieve (close to) zero fatalities. The nature of road transportation has changed significantly over recent decades (e.g. increased traffic density, growing vehicle size and higher centre of gravity), and so has the crash problem.

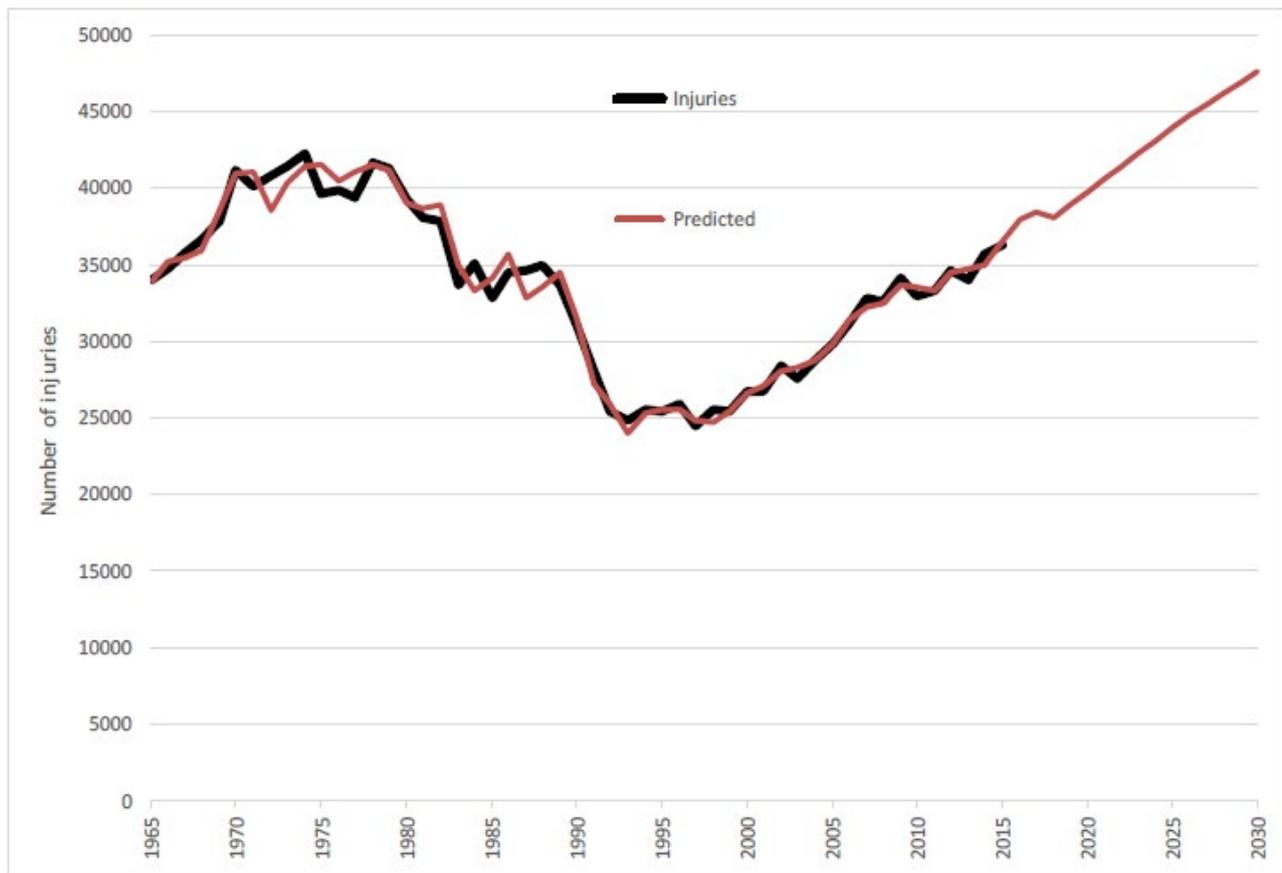
VicRoads' evaluation of the police records of more than 60,000 casualty crashes including 1,166 fatalities over 5 years (2014-2018) has found that around 40% of all analysed casualty crashes involved a 'Small Crash Category' as a contributing factor, meaning that this factor was none of the 'classical' ones like speeding, alcohol/drug use, fatigue or distraction etc. Crashes such as those attributed to the causes 'Congestion', 'Animal' or 'Weather' typically involve a surprise element (i.e. there is often 'virtually no reaction time' for motorists) and crash avoidance is often beyond human capability.

### **Method**

A study tour of nine countries, a comprehensive literature review and conversations with many of the key experts and corresponding authors were undertaken. Insights from an earlier detailed crash analysis of the casualty crashes on the Monash Freeway and the Eastern Freeway (Hovenden et al., 2020) were also investigated. This combined approach was complemented by daily traffic studies which demonstrated the impact of weather variability and traffic flow complexity on many critical driving manoeuvres and crashes. This together resulted in the documentation of the overall view from a road operator's perspective.

In order to gain some more transparency around the factors that influence the needed braking distance and therefore determine the distance to an object that is needed to 'absorb' such a critical braking manoeuvre, the corresponding equation for the calculation of the braking distance was presented and

analysed in regards to all the different factors that can impact on Vehicle speed, Perception and Reaction time and Friction.



**Figure 1. Victorian fatalities since 1970 (Source: VicRoads) and actual and predicted Australian hospitalised road injuries (Source: BITRE estimates)**

## Results and Conclusions

The causation of a crash is generally very complex with a multitude of factors leading up to it. All crashes are unique, even though they appear similar when classified by a code. It is therefore necessary to tackle the multitude of these contributing factors, rather than to single out individual ones such as those linked to driver misbehaviours. Many crashes involve a surprise element (e.g. an animal jumping in front of a motorcycle), leaving ‘virtually no reaction time’ for motorists, and crash avoidance is often beyond human capability.

Within each pillar (or in the new terminology ‘cornerstone area’) of current safe system strategies there are opportunities for additional road safety measures and more efficient / effective implementations of existing measures. The study of world’s best practice suggests that a greater focus is needed locally on further improving the emergency response to crashes (Oguchi, 2016). It should be noted in this context that Japan is still on a declining trajectory regarding road crashes and related fatalities (Nippon.com, 2021).

In the technology space there is insufficient emphasis on leveraging relatively simple, proven technologies such as speed limiters, Smart ITS comprising real-time weather and congestion warnings, high-performing brakes and tyres including tyre pressure monitoring systems / run flats, or more complex but also proven technologies such as eCall. In the behavioural space, the mental workload for motorists could in some instances be reduced by simple measures such as the avoidance of billboards along high-volume motorways with complex traffic conditions, where it is now evident that the social costs of crashes caused by distraction far outweigh the corresponding revenue (Gitelman et al., 2019).

The counterpart to the ‘reducing the braking distance’ approach such as through influencing the Vehicle speed, Perception and Reaction time and Friction is the ‘provision of more road space’ approach where it is expected that, for example, systematically enforcing the legally required minimum distance of trucks to the long vehicle in front, as is done overseas, would also contribute to the avoidance of severe, multi-vehicle crashes involving trucks which are a regular occurrence on heavily trafficked motorways (Westfaelische Nachrichten, 2017).

Closing these gaps in current strategies is an opportunity on the way to achieving the ambitious goal of having (close to) zero fatalities in the foreseeable future.

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## **Mentoring to increase compliance and road safety**

Tegan Pearce

Department of State Growth, Tasmanian Government

### **Abstract**

Previous studies have indicated that unlicensed drivers are more likely than licensed drivers to be at fault and more seriously injured when involved in a crash.

Having never possessed a driver licence is more prevalent among people with socio-economic disadvantage, low levels of literacy, difficulty understanding English language, difficulty establishing identity, socio-economic disadvantage or living in remote communities.

The Tasmanian Learner Driver Mentor Program (LDMP) was established to simultaneously address the barriers to entering Tasmania's Graduated Licensing System (GLS) and to increase safe driving practices through compliance with GLS requirements. Programs are delivered by community-based organisations and give disadvantaged learners access to a vehicle and volunteer mentor supervisor drivers (mentors) who receive specific training relating to social issues that can contribute to unlicensed driving and unsafe driving behaviours.

### **Background**

Research has shown people more likely to participate in unsafe driving are those with poor family relationships, anti-social behaviours and peers, conduct disorders and lower than average attentional abilities (Harriss et al. 2014). These traits have been identified in community consultation in Tasmania to overlap with people who are likely to experience barriers entering the licensing system.

Drivers who have never held a full licence are five times more likely to be involved in a serious crash than licensed drivers (Watson 2004) and nearly five times more likely to be involved in a fatal crash (De Young et al. 1997). These drivers are unlikely to have gained sufficient experience through the GLS and may be deficient in the knowledge and skills required to drive safely.

### **Purpose and Description of Project**

The LDMP began in 2007 and supports learners that do not have access to a supervisory driver and/or vehicle, and cannot afford professional lessons to obtain the 80 supervised driving hours required in the GLS by giving them access to a vehicle and mentor. Having mentors provides a range of benefits to learners including a role model that can build greater social connection and road safety attitudes and behaviours among participants (Freethy 2012).

Mentors spend a significant amount of time with learners which presents a unique opportunity to shift the attitudes of learners, reduce non-compliance and increase safe driving practises.

LDMP provides ongoing training and support to mentors to be a supervisory driver but also address issues with participants such as poor family relationships and anti-social behaviours. This is key in addressing underlying attitudes and behaviours that may lead someone to drive unlicensed or unsafely and is a clear strength within this model.

## Effectiveness and Evaluation

The LDMP has been evaluated as a cost-effective option to get people into the GLS while increasing social inclusion, leading to greater road safety outcomes. Participants reported they were less likely to drive without a licence and would practice safer driving as a result of the program. Further, almost every participant reported feeling that their mentor provided sound road safety advice and social guidance.

***“My mentor is patient and [is] focused on safety skills rather than deadlines or hours.” (Program Participant)***

Each month an average of 25 LDMP participants pass their P1 Practical Driving Assessment (P1 PDA).

## Next Steps

The LDMP is underpinned by a continuous improvement program and is currently expanding on the mentoring and social component due to its demonstrated success towards improved compliance and road safety attitudes.

Recent activity includes improved holistic induction and training package aimed at upskilling mentors.

Further improvements include a data collection system that can track de-identified data to examine individual journeys through the program with the potential to track attitudes and behaviours that are linked to increased crash risk.

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## Modelling the crash effects of random and targeted roadside drug tests in Victoria, particularly on drug driving involving methylamphetamine

Max Cameron<sup>a</sup>, Stuart Newstead<sup>a</sup>, Belinda Clark<sup>a</sup>, Luke Thompson<sup>a</sup>

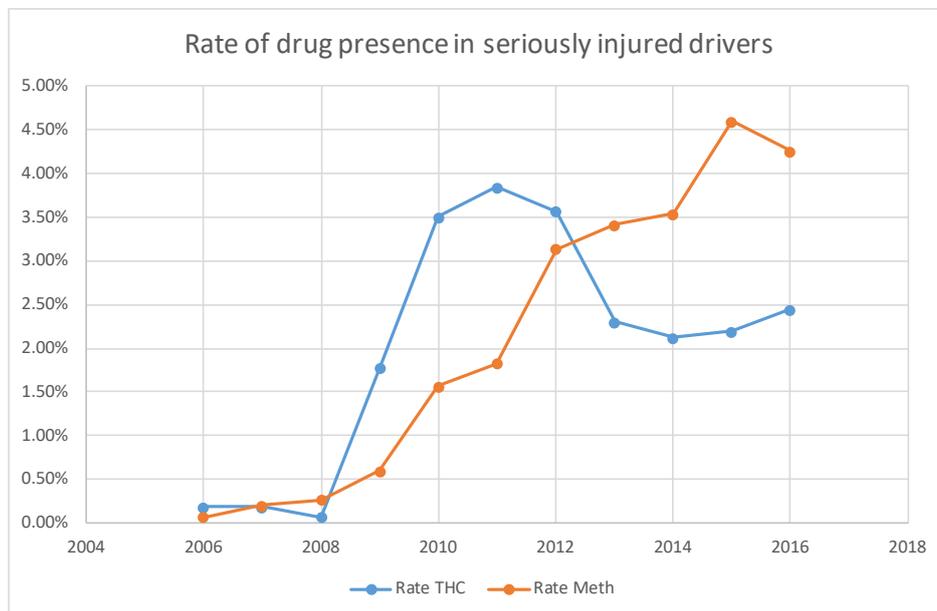
<sup>a</sup>Monash University Accident Research Centre

### Abstract

The prevalence of Methylamphetamine (MA) in drivers on the road and the seriously injured has trended up steeply in Victoria during the last decade. Drug-driving with MA can be deterred by increasing the positive detection rate from roadside drug testing, particularly by targeted testing. Recent research has modelled the relationships between prevalence of THC and MA in seriously injured drivers and (a) random and targeted drug tests during 2006-2016 and (b) the positive detection rates from these tests. The 50% increase in roadside drug tests in Victoria during 2019, particularly targeted tests, is estimated to have saved 3 fatal crashes and 55 serious injury crashes. Further increases in targeted and random roadside drug tests are warranted, up to at least 426,500 total tests per year, and saving 24.5 fatal crashes and 140.5 serious injury crashes per year.

### Background

Preliminary Oral Fluid tests (POFTs) for drugs were introduced in Victoria in December 2004. The presence of Methylamphetamine (Meth) in seriously injured drivers has increased consistently whereas THC presence initially increased then decreased from 2011 (Figure 1).



**Figure 1: Rate (%) of THC and Methylamphetamine presence detected in seriously injured drivers in Victoria, 2006-2016**

### Method

Recent MUARC research has modelled the relationships between drug presence in seriously injured drivers and (a) increased POFTs during 2006-2016 and (b) the positive detection rates from these tests (Clark, Thompson and Newstead, 2019). They found that:

- Relative odds of THC involvement in seriously injured drivers decreases with the increased POFTs
- Relative odds of Methylamphetamine involvement in seriously injured drivers decreases with the increase in the positive detection rate of any proscribed drug.

The relative odds due to THC involvement decreased by 3.88% per 1000 annual POFTs in each Police Region. The relative odds due to Meth involvement decreased by 6.78% per 1% point increase in the percentage detection rate.

Relationships between drug involvement in killed drivers and annual numbers of POFTs had been previously found by Cameron (2013) from Victoria Police data published by Boorman (2010). The relative risk of driver fatality due to an impairing drug decreased by 0.097% per 1% increase in random POFTs.

A traffic enforcement resource allocation model (TERAM) had been previously developed for Victoria Police to assist them to plan levels of enforcement of speeding, drink- and drug-driving, and unlicensed driving (Cameron, Newstead and Diamantopoulou 2016). The new relationships have been included in TERAM and allow the savings in serious injury crashes to be modelled. The role of the targeted POFTs has also been included, including their effect on overall detection rates.

## Results

### *Effects of increased POFTs and detection rates during 2019*

During the 2018-19, Victoria Police planned to increase the annual POFTs to 150,000 from the 100,000 tests in the three previous years. TERAM was used to estimate the savings in fatal and serious injury crashes during 2019 from a base level in 2017 (99,769 POFTs). POFTs allocated to random operations were scheduled to increase by 14% whereas targeted POFTs were scheduled to increase by 86%. Table 1 shows that the increase in POFTs during 2019 could be expected to have saved just over 3 fatal crashes and nearly 55 serious injury crashes. The increased POFTs would return social cost benefits more than 3.2 times the increased program cost. The marginal BCR indicates that there is further economic value if the annual POFTs were increased further.

### *Effects of further increases in roadside drug testing*

A range of percentage increases in the random and targeted POFTs were considered until increases were found that produced a marginal BCR of one (Table 1). This maximum level was indicated if the 50,873 random POFTs conducted during 2017 were increased by 200% and the 48,896 targeted POFTs were increased by 460%. In the short term, the positive detection rate would increase from 8.6% to 10.6%, reflecting the different percentage increases in each type of operation. For the given percentage increases in random and targeted POFTs, TERAM estimated that 24.5 fatal crashes and 140.5 serious injury crashes would be saved per year.

Estimates of road safety benefits calculated in this analysis assume that the expansion of the roadside drug testing program has no negative impacts on the delivery of other police enforcement programs, such as roadside alcohol testing, due to constraints on overall human resources.

**Table 1. Crash savings per year, benefit-cost ratio (BCR) and marginal BCR from POFT increases**

Enforcement type	Base level 2017 (Tests)	Increase in level (%)	Increase (Tests p.a.)	Fatal crashes saved per year	Serious injury crashes saved per year	BCR (Increase benefits/ increase costs)	Marginal BCR
<b>INCREASES DURING 2019</b>							
<b>Random POFT</b>	50,873	14.15%	7,199				
<b>Targeted POFT</b>	48,896	85.85%	41,977				
<i>Random + Targeted</i>	99,769	49%	49,176	3.10	54.62	<b>3.23</b>	3.54
Increased total POFT			<b>148,945</b>				
<b>FURTHER INCREASES</b>							
<b>Random POFT</b>	50,873	200%	101,746				
<b>Targeted POFT</b>	48,896	460%	224,922				
<i>Random + Targeted</i>	99,769	327%	326,668	24.54	140.53	<b>1.89</b>	1.00
Increased total POFT			<b>426,437</b>				

## Conclusions

Further increases in targeted and random roadside drug tests in Victoria are warranted, up to 426,500 total tests per year. It is estimated that 24.5 fatal crashes and 140.5 serious injury crashes would be saved per year. Resources should not be diverted from roadside breath testing for alcohol to facilitate the increases in roadside drug testing.

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## **Development of a truck driver public health project: Mental and Physical Safety (MaPS) on our Roads.**

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### **Abstract**

Individual, environmental and organisational factors can contribute to poor physical and mental health outcomes among truck drivers. The Injury Matters project, *Mental and Physical Safety (MaPS) on our Roads*, targets health issues facing Western Australian (WA) truck drivers and keeping them safe on our roads. A co-design approach has been applied to inform the *MaPS on our Roads* strategies.

During the consultation phase, surveys, in-depth interviews and focus groups were conducted with WA's heavy vehicle industry. Overall results indicate that WA truck drivers frequently witness road traffic incidents while at work and are aware further actions are needed to improve their health status. However they experience a number of barriers to engaging in existing health and wellbeing initiatives.

Consultation results have been used to inform the *MaPS* project focus areas, engagement strategies and future work that aims to improve the mental and physical safety of WA's heavy vehicle operators.

### **Background**

A range of individual, environmental and organisational factors can contribute to poor physical and mental health outcomes among truck drivers (Hill et al., 2015; National Transport Commission, 2019).

Additionally, due to Western Australia's (WA's) vast and remote road network, truck drivers are often the first to come across the scene of a road traffic incident. This has potential for long-term mental health consequences, with Australian research indicating that up to 29% of road traffic crash survivors develop post-traumatic stress disorder (Heron-Delaney et al., 2013).

With the support of the National Heavy Vehicle Regulator, Injury Matters aims to improve the mental and physical safety of WA's heavy vehicle operators through the *Mental and Physical Safety (MaPS) on our Roads* project.

### **Purpose of project**

The purpose of this presentation is to provide an overview of formative consultation with heavy vehicle drivers to inform the *MaPS on our Roads* project.

### **Project methods**

To guide the direction of the *MaPS on our Roads* project, consultations were conducted with; WA truck drivers, the WA heavy vehicle industry and family members of WA truck drivers. These consultations aimed to provide project staff with an understanding of;

1. The profile of WA's heavy vehicle industry
2. Truck drivers involvement in road traffic incidents
3. Health status, issues and behaviours of truck drivers
4. Enablers and reinforcers of truck driver health behaviours
5. Existing heavy vehicle industry health and wellbeing initiatives
6. What additional health and wellbeing initiatives are needed.

The five-month consultation process involved the development and implementation of an online truck driver survey and industry survey, in-depth interviews and focus groups with 233 of the project's target audience. The four consultation tools were informed by existing validated tools and aligned to the project's aims.

Individuals from WA's heavy vehicle industry were invited to participate in the consultations via targeted communication strategies, including; social media posts, industry publications and direct contact with heavy vehicle organisations in WA.

All quantitative results gathered through the online truck driver and industry surveys were analysed and reported as frequencies using Jamovi (Version 0.9) data analysis software. All open-ended responses were analysed and reported through themes.

### **Lessons learned**

Consultation results indicate that WA's heavy vehicle industry; is ageing, self-identify as having a suboptimal health status and frequently witness road traffic incidents while at work. Despite being aware of the importance of conducting activities for their physical and mental health, participants identified; social isolation, dictated work schedules, restricted access to health services and family commitments as significant barriers from participating in health and wellbeing strategies.

Truck drivers who engaged in the consultation process were able to recall some health and wellbeing initiatives provided by their organisation, however, they acknowledged that they did not regularly engage in them.

To improve WA truck driver's engagement in health and wellbeing initiatives, consultation participants highlighted the need for *MaPS on our Roads* project activities to; be endorsed by WA truck drivers, acknowledge local seasonal challenges, include reference to statistics and complement existing organisational strategies.

### **Implications and next steps**

Consultation results have been used to inform the *MaPS on our Roads* project campaign topics and engagement strategies, and will continue to inform future work that aims to improve the mental and physical safety of WA's heavy vehicle operators.

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## **Roads That Cars Can Read assessment: Practical Applications in NSW**

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### **Abstract**

A 100 point ‘Roads That Cars Can Read’ checklist suited to Australian conditions was developed by Safe System Solutions Pty Ltd for Transport for NSW. This checklist was used to undertake Route Risk Assessments for three regions: the planned Smart Shuttle Autonomous Vehicle (AV) route in Olympic Park, Sydney and two planned regional automated vehicle trials; one in Armidale and one in Newcastle.

The Roads That Cars Can Read Route Risk Assessments revealed numerous risks that may affect performance of autonomous vehicles. This paper details the key elements of a ‘Roads That Cars Can Read’ assessment and identifies issues for road designers and road operators when managing a road for autonomous vehicles.

### **Background**

There is much work being done around the world regarding the standards of infrastructure that can support Connected and Automated Vehicles (CAV) operation. In recent times a stronger consensus has developed on what types of infrastructure features are required. Austroads (2019) tells us that for active safety systems that intervene but do not continuously control the vehicle, there is a major focus on the two types of infrastructure most relevant to interpretation of the road by on-board sensors:

- line marking, including line types, line quality, curve radius
- traffic signs – position as well as types.

For automated driving that continuously controls the vehicle, the requirements include those above, and also include:

- availability of high-definition mapping
- availability of continuous data connectivity, particularly cellular networks.

EuroRAP identified (EuroRAP, 2014) that the common standards could be adopted and applied by all European nations. This meant mainly ensuring simple consistency in the width of white lines and ensuring that they reflect back enough light to be read by drivers and in-vehicle equipment in all weathers. It meant removing the unnecessary inconsistencies in fonts, colours, sizing and shape that ensued when nations implemented basic safety signs in different ways. It meant understanding the importance of marking the edges of roads. In Australia this standardization and harmonization aims to be encapsulated in Australian Standard AS1742 – Manual of uniform control traffic devices, however, there remain many inconsistencies and many configurations used in Australia that are not recognized by international vehicle systems.

### **Development of a ‘Roads That Cars Can Read’ Checklist**

Following internal and external consultation, Safe System Solutions Pty Ltd developed a 100 point ‘Roads That Cars Can Read’ checklist suited to Australian conditions based on the following categories and subcategories:

- Traffic Guidance Lines and Pavement Messages
- Signs

- Sight Lines
- Road Features
- Signals
- Temporary & Roadwork Signs and Line Markings
- Other Items

### **Applications of the Roads That Cars Can Read Checklist**

The Smart Innovation Centre of Transport for NSW (TfNSW) intends to, and has been, undertaking CAV trials in Sydney and in regional areas. This is because connected and automated vehicle technology will enable driverless vehicles, which will be a major step change for transport. This technology has the potential to increase safety, minimise congestion, improve productivity and help make people more mobile.

Safe System Solutions Pty Ltd was engaged by TfNSW to undertake Route Risk Assessment for the planned Smart Shuttle (AV) route in Olympic Park, Sydney and the planned regional AV trials in Armidale and in Newcastle.

The risk assessments focused on the road and roadside environment and its interactions with the AV. They focused on the safety of all road users (including users of the Smart Shuttle) and used the Safe System Solutions Pty Ltd 100 point “Roads That Cars Can Read” checklist.

Figure 1 provides an example of the checklist results for the Olympic Park shuttle. This example illustrates some potential deficiencies in relation to sightlines. More detailed Route Risk Assessments and recommended risk mitigation measures were provided to TfNSW and incorporated into the project. Further details will be outlined in this paper.

### **Discussion**

Roads That Cars Can Read assessments are one tool in managing risk associated with AV trials. Because of potential liability issues in the event of an incident rigorous scientific evaluations (particularly of line-marking and signage retro reflectivity) are critical before any on-road trials are initiated.

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Austrroads 2019 Infrastructure Changes to Support Automated Vehicles on Rural and Metropolitan Highways and Freeways Project Findings and Recommendations (Module 5), Austrroads, Sydney.

EuroRAP 2013 Roads That Cars Can Read: A Quality Standard for Road Markings and Traffic Signs on Major Rural Roads, EuroRAP and EuroNCAP.

<b>Roads that Cars Can Read Checklist</b>			
	Yes	No	NA
Are signs appropriate to the driver's needs? (for example, direction signs, advisory speed signs, etc.)	✓		
Are traffic signs correctly located, with adequate lateral and vertical clearance?	✓		
Have signs been placed in locations which facilitates easy visibility and adequate response time?	✓		
Are signs located so that visibility is maintained to/from accesses and intersecting roads?	✓		
Are signs able to be seen without being hidden by their background or adjacent distractions?	✓		
Will the signals be obscured by landscaping in the future (e.g. future tree growth, seasonal foliage, etc.) ?			✓
Have the sign orientations been specified which take into account headlight reflect light back to the vehicle?			✓
In daylight and darkness, are signs satisfactory regarding visibility and clarity of message?			✓
In daylight and darkness, are signs satisfactory regarding visibility and readability/legibility at the required distance?			✓
Are high intensity boards likely to be affected by sunset/sunlight? (consider the sun's movements through the year)			✓
Will the signs and markings be clear in all conditions, including day/night, rain, fog, etc.?	✓		
<b>Consistency Between New Design and Existing conditions</b>			
Are new signs consistent with existing signs?			✓
Is the transition from old work to new work satisfactory? (i.e. no uncertainty or ambiguity at the transition)			✓
Are sign reflectivity/illumination the same or similar to that of existing signs?			✓
Are new signs located away from service road signs?			✓
<b>Sight Lines</b>			
Are sight lines free of boundary fences?	✓		
Are sight lines free of street furniture?		✓	
Are sight lines free of parking facilities		✓	
Are sight lines free of signs?		✓	
Are sight lines free of landscaping?	✓		
Are sight lines free of bridge abutments?	✓		
Are sight lines free of potential queued traffic (e.g. buses)?		✓	
Are sight lines free of any other local features?		✓	
Are sight lines distances satisfactory at roundabouts?	✓		
Are sight lines distances satisfactory at intersections?	✓		
Are sight lines distances satisfactory at entry/exit ramps?			✓
Are sight lines distances satisfactory at property entrances?	✓		
Are roundabouts free of any unusual features which could affect the sight line?		✓	
Are Intersections free of any unusual features which could affect the sight line?	✓		

**Figure 1. Example of a section of a completed checklist indicating, in this instance, potential issues with sight lines**

## ANCAP Speed Limit Information Function Assessment

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<sup>a</sup> Australasian New Car Assessment Program

### Abstract

ANCAP have conducted testing and assessment of Safety Assist functions of vehicles since 2018. This includes performance assessment of a Speed Limit Information Function (SLIF) through on-road testing. A range of current model vehicles are fitted with a SLIF that can successfully detect and present applicable speed limits to the driver. In 2018 to 2021 ANCAP assessed 81 vehicles fitted with SLIF with the majority of the tests conducted in Sydney and Melbourne.

This paper will outline how ANCAP undertakes the assessments, discuss the findings of these assessments and the issues discovered with the signs, locations and maps. ANCAP found there is inconsistency in signage around Australia making recognition by the vehicle difficult and inconsistent. The placement of road signs and street trees also must be considered in the location of a speed limit sign or a conditional speed limit sign.

### Background.

ANCAP SAFETY is Australasia's leading independent vehicle safety authority. ANCAP safety ratings are published for a range of new light vehicles. All ratings published by ANCAP with a date stamp of 2018 onwards include assessment to confirm the functionality of the Speed Limit Information Function (SLIF) of the vehicle on Australasian roads. A SLIF provides advice to the driver on the speed limit, whether there is a conditional speed limit, and whether the vehicle is exceeding the identified limit, providing the driver with necessary information to drive within the speed limit.

### Assessment Process

The vehicles are assessed on roads with a variety of road signs and speed limit changes, including school zones, residential and city/urban streets, highways and road work areas. The vehicle detects the relevant speed limit by camera, map or a combination of both. The detected speed limit is presented to the driver who can, depending on the system, adjust a manual speed limiter; accept the revised speed limit with the press of a button; or have the system automatically accept and adjust the vehicle speed.

### Results

ANCAP released 52 new ratings in 2018 and 2019. Of these, 36 models had a SLIF. The camera-based systems performed well in the majority of cases. The map based systems performed well, with minor mapping issues but were unable to detect some changed speed limits. Combination systems were able to realise the benefits of both systems.

There are a wide variety of school zone signs used around Australia. ANCAP's assessment protocol requires a vehicle to detect the school zone sign as a conditional sign with a speed limit and time of day requirement. Inconsistencies within and between jurisdictions has led to, in some circumstances, up to 5 different designs being used within 1 km of driving. Reducing the variation in designs will reduce the library of signs required in the SLIF system and increase the successful detection rate.

Placement of other road signs and street trees can partially block or overshadow speed limit signs. Also, placement of parking restriction signage close to speed signs can partially block the speed limit sign and so not be recognised by on board cameras.

### **Conclusion**

A range of current model vehicles are fitted with a Speed Limit Information Function that can successfully detect and present applicable speed limits to the driver. There is inconsistency in signage around Australia making recognition by the vehicle difficult and inconsistent. The placement of road signs and street trees must be considered in the location of a speed limit sign or conditional speed limit sign.

# Community Engagement and Attitudes for Road Safety in Western Australia

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## Abstract

As a result of a review of the Western Australian Road Safety Commission's (Commission) public participation and engagement activities carried out during 2019, broad interest in the Commission's community attitude and behaviour research was generated. The scope of this paper is the reporting and discussion of the Commission's:

- community attitude and self-reported behaviours relating to drink driving, seatbelts, mobile phone use and speeding; and
- community perceptions and beliefs regarding road safety in Western Australia (WA) using the Kantar Public 10C Citizen Engagement Framework.

Several years of survey results are provided and associated results from WA's driver segmentation research and road safety strategy development are discussed. Additionally, how the 10C framework results are likely to influence the development of WA's road safety strategy 2020 – 2030 outlined in conjunction with results from the community consultation process conducted for the development of the strategy.

## Background

The Western Australian (WA) Service Priority Review *Working Together One Public Sector Delivering for WA* signalled the development and introduction of a whole of government approach to citizen engagement and a citizen centric service model for Western Australia (WA). An initial step to prepare for a whole of government approach the Road Safety Commission (Commission) conducted a review of its public participation and engagement activities. Included in this review was WA road user attitude, behaviour, perception and belief research conducted for the Commission.

The review was reported in the November 2019 edition of the Australasian College of Road Safety Journal and generated unmistakable interest in the actual results of the various community research activities. This paper aims to respond to this interest and share the information obtained regarding WA.

## Community research methods used by the Commission

The Commission's community attitude, behaviour, perception and belief research is to gather evidence to inform community education and awareness raising activities; ultimately to engage the community in effort to improve road safety outcomes and reduce road trauma. Whilst not the primary purpose, the results of the community research have recently been used to inform the development of the WA road safety strategy for 2020 – 2030 in conjunction with results from the community consultation for the strategy.

### ***Community attitudes and self-reported behaviours, including driver segmentation***

The methodology is an online survey of WA road users, which for 2015 had 1,629 respondents and for 2018 had 2,116 respondents. The data is post-weighted at the analysis stage to the population parameters of WA drivers based on licensing statistics provided by the Department of Transport WA. The survey obtains the self-reported data of respondents regarding attitudes about drink driving, seatbelts, mobile phone use and speeding.

Driver segmentation research has been conducted during 2015 and 2018. For 2015 this work included deep dive workshops to further explore attitudes and beliefs. The deep dive workshops were conducted with a small number of respondents that were identified to represent one of nine specific segments within the driver segmentation model. The segmentation uses the Sheth-Frazier Model.

Table One: Driver Segmentation Model provides the segments and illustrates how road users are classified using the example of exceeding the speed limit. Segment 1 road users are those with an attitude and self-reported behaviour that is most supportive and compliant with the relevant road law/s. Segment 9 are the least supportive and consistently consciously exceed the speed limit.

***Table One. Driver Segmentation Model***

Attitude: It's ok to exceed the speed limit in certain situations	Behaviour <i>Thinking about all the trips you do on our roads, on both week and weekend days: how regularly, if ever, would you say you drive over the speed limit (regardless of the reason).</i>		
	Never	Irregularly	Regularly
Disagree (Positive)	Segment 1 (S1)	Segment 4 (S4)	Segment 7 (S7)
Neutral (Ambivalent)	Segment 2 (S2)	Segment 5 (S5)	Segment 8 (S8)
Agree (Negative)	Segment 3 (S3)	Segment 6 (S6)	Segment 9 (S9)

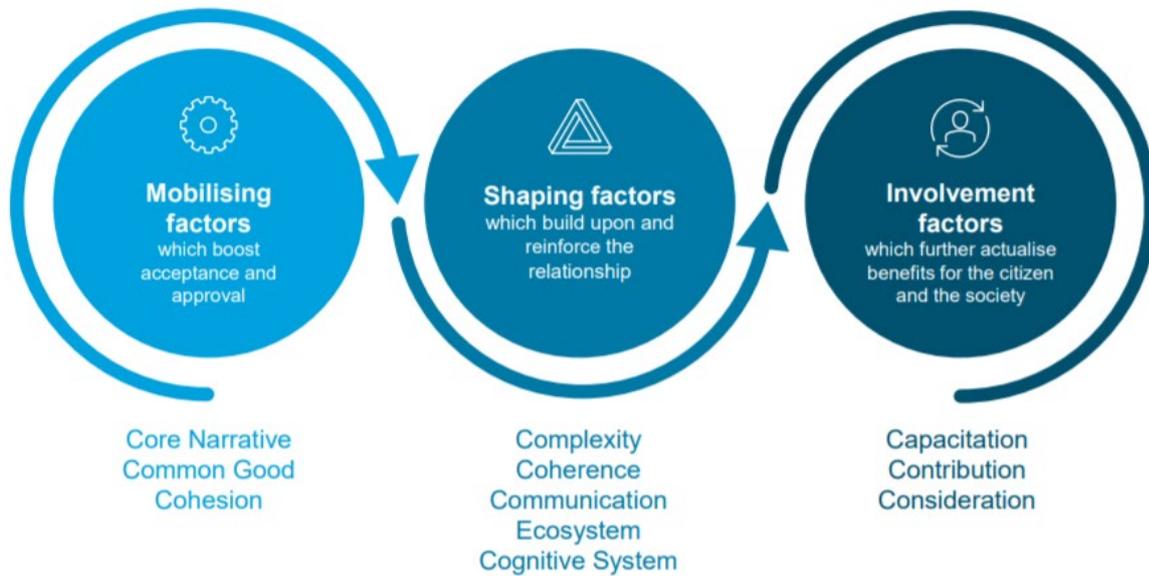
Table Two: Summary of Driver Segmentation Results provides an overview of the results for 2015 and 2018. Equivalent result tables are provided for drink driving, seatbelt use and mobile phones in the full article.

***Table Two. Summary of Driver Segmentation Results for Exceeding the Speed Limit***

	2015	2018	Change
S1	6%	7%	▲ 1%
S2	1%	3%	▲ 2%
S3	1%	3%	▲ 2%
S4	25%	24%	▼ 1%
S5	15%	15%	-
S6	36%	35%	▼ 1%
S7	2%	2%	-
S8	2%	2%	-
S9	11%	10%	▼ 1%

**10C Framework perceptions and beliefs**

The Kantar Public 10C Citizen Engagement Framework includes ten engagement dimensions which are grouped into three factors, as illustrated in Figure One: 10C Citizen Engagement Framework.



**Figure One: 10C Citizen Engagement Framework**

Based on the scores provided by survey respondents, the results for citizen engagement for road safety in WA are positive. Figure Two: Engagement Index, provides the overall engagement result. The score for each of the ten factors that contribute to this result and the implications for the profile established with the various scores inform the action required to improve the overall result. The width of the ‘All’ Engagement Index shape indicates the distribution of responses.



**Figure Two: Engagement Index**

WA’s scores for core narrative, cohesion and contribution indicate that more work is required for these factors if the overall result is to improve. Results for each factor and additional work that has been commissioned regarding these factors is discussed in the full article.

**Road safety strategy development consultation**

Between June and October 2019; the WA community were invited for suggestions regarding what should be included in a new road safety strategy. A total of 1,310 on-line surveys were submitted, 1,787 responses were provided for quick poll surveys, and 7,258 comments were recorded from the public, stakeholder and special interest group forums. Figure Three: Common Community Suggestions, illustrates the most common suggestions from the community grouped according to the Organisation for Economic Cooperation and Development road safety safe system principles. Community road safety ambition differed according to input mechanism, with those attending forums being more ambitious than those responding online.



**Figure Three: Common Community Suggestions**

**Conclusion**

The community input indicates that further work is required to engage WA’s citizens in road safety and the aim to reduce road trauma to zero serious harm.

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## Cardiac disease and driver fatality

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### Abstract

A retrospective review of autopsy files at Forensic Science South Australia (FSSA) in Adelaide, Australia was undertaken over a 13 year period between January 2005 and December 2017 for motor vehicle drivers aged  $\geq 40$  years who died while driving a vehicle. Autopsy examinations were performed on 303 drivers and 72 passengers. Of those traumatic fatalities, 48 (15.8%) of drivers had severe stenosis compared to 15 passengers (20.8%) and was not statistically significant. Although a concern was that drivers with significant cardiac disease may have increased rates of death in crashes with the causative role of the underlying cardiac disease obscured by trauma, this does not appear to be the case. Instead there is a distinct subgroup of drivers who die from cardiac events, and not trauma, while driving who may be increasing in number given the aging population.

### Background

The true impact of cardiovascular disease in the driver population has been inadequately assessed in Australia. This is due to limitations in mixed report methodologies, under-reporting in national population data, inadequate recording of medical history following collision, and discrepancies in evaluating disease severity. Studies in fatal and non-fatal crashes (Ronna et al., 2016) have demonstrated a higher incidence of cardiac disease in involved drivers. Oliva et al. further described the presence of severe coronary artery disease in sudden death collisions, with 86.2% of fatalities showing severe signs of the disease, predominantly in males (Oliva et al., 2011). In Australia, as in many parts of the world, CVD related medical interventions such as bypass surgery will temporarily suspend driving however it does not prohibit individuals from driving commercial or private vehicles in future (Ltd, 2012; Oliva et al., 2011; Tervo et al., 2008))

### Method

Coronial autopsy reports (2005-2017) were searched for all cases of traumatic and non-traumatic motor vehicle fatalities for motor vehicle drivers  $\geq 40$  years. Traumatic death was defined as being the result of motor vehicle trauma, with a high severity of ischaemic heart disease (severe cases of coronary stenosis of one vessel ( $>75\%$ ) (Muller et al., 1991)). Non-traumatic CVD death included ischaemic heart disease, myocardial infarction and cardiomegaly. Age, sex, Body Mass Index (BMI) of de-identified decedents were recorded, along with cause of death. Cardiomegaly was determined using predicted normal heart weight (g) as a function of body weight (Kitzman, Scholz, Hagen, Ilstrup, & Edwards, 1988). Passengers aged  $\geq 40$  years from the same autopsy database were used as a control group.

### Results

A 303 of the driver fatalities due to vehicular trauma underwent medico-legal autopsies at FSSA. The average age for drivers was 58.5 years (range 40–93 years) with 218 (71.9%) males having an average BMI of 28.8 (range 15.1-57.2). A total of 72 passenger fatalities (aged  $\geq 40$  years) with medico-legal autopsies, the average age was 63.3 years (range 40–93 years) with 34 (47.2%) males having an average BMI of 28.2 (range 17.6-45.7). Ischaemic heart disease was found in 15 passengers (20.8%) with an average BMI of 28.08 (range 22.9-37.9). An additional 63 driver fatalities occurred over the

study period due to a cardiac event while driving. The average age of these drivers was 64.5 years (range 42-88 years) with 58 male fatalities (92.1%) having an average BMI of 30 (range 17-45).

### **Conclusions**

Although cardiac disease may cause rapid incapacitation, this study has not shown a higher rate of cardiac disease in drivers in fatal vehicle crashes compared to passengers. A concern that initiated this study was that subsequent trauma following vehicle impact may skew the determination of the cause of death away from heart disease, but this does not appear to be the case. Given the aging population it may be that these types of deaths are the ones that will become more common in the future. An existing challenge is the unknown number of individuals with underlying heart disease which remains occult until death.

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## Side impact intrusion in child passenger deaths and the performance of child restraint systems

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### Abstract

Side impact crashes are more likely to cause intrusion into the occupant space than other crash types which is a significant risk factor for serious injuries to child passengers. All child deaths in NSW from 2007 to 2016 were reviewed in this study, finding that intrusion into the occupant space appears to be the most significant factor related to child passenger deaths when children are appropriately and correctly restrained. Laboratory tests were devised and performed to examine the influence of intrusion and door topology on the injury risk of restrained child passengers. Armrest size and shape was found to affect head injury risk, with a flat door providing the lowest risk. This work demonstrates that optimising compatibility between vehicles and child restraints may be a way to minimise child injury risk in side impacts when children correctly use appropriate restraints.

### Background

Side impact crashes pose the greatest risk of injury to child occupants, particularly when seated on the impacted side of the vehicle (Agran, Winn, & Dunkle, 1989; Arbogast, Chen, Durbin, & Winston, 2004; Langwieder, Hell, & Willson, 1996). Side impacts are more likely to cause injury by intrusion into the occupant space than other crash types, and this intrusion can result in high severity injuries (Arbogast, Cornejo, Kallan, Winston, & Durbin, 2002). Interior door shape, including the armrest influences injury risk to adult occupants in side impact crashes (Viano, 1991) but has not yet been studied for child occupants.

The aims of this study were to understand the prevalence and circumstances of child passenger deaths in side impact crashes in New South Wales and to investigate the effect of intruding door topology on the side impact performance of child restraint systems.

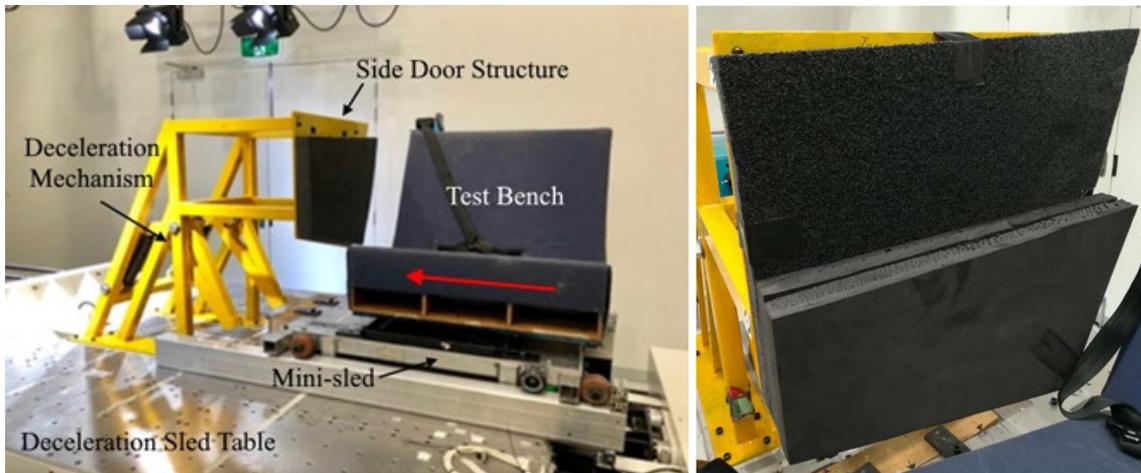
### Method

Data provided by the NSW Child Death Review Team (CDRT), summarising relevant crash, injury and restraint data for all child (0-12 years) deaths in passenger vehicles in NSW between 2007 and 2016 were reviewed. The incidence of side impact crashes, intrusion as a primary contributor to death, types of child restraints used and injuries to the children were examined in cases where evidence suggested the child passenger was appropriately and correctly restrained.

A test apparatus was constructed to simulate intrusion of a side door structure into the rear seat occupant space in a side impact (see Figure 1). A child restraint test bench (AS/NZS 3629) was mounted on an independently movable 'mini-sled' on top of the deceleration sled at the Transurban Road Safety Centre at NeuRA. A rigid side door structure, with various shaped inner door panels mounted to it, was affixed to the deceleration sled table. On impact, the main sled decelerated, while the movable platform and test bench continued to move forward under the rigid door structure at 32 km/h, to an approximate intrusion depth of 250 mm, corresponding to intrusion depths measured in full scale crash tests (Johannsen et al., 2007), making contact between the child restraint and inner door surface.

A Q6 test dummy was placed on a high-back booster seat on the test bench and subjected to intruding door side impacts with varying intruding door shapes. Intruding door shapes included a no-armrest

case (door foam 35.2 kg/m<sup>3</sup> density, 50 mm thick) and three different simulated armrest sizes (low, medium and high) consisting of polyethylene foam (60 kg/m<sup>3</sup> density, 72 mm thick) with foam properties based on NHTSA’s side impact test development (Brelin-Fornari & Janca, 2014). Each test condition was repeated. Head accelerations of the dummy were recorded in each test, in accordance with SAE J211 (95).



**Figure 1. Intruding door test method (left) showing mini-sled, test bench and side door structure mounted to the sled table of the deceleration sled. The red arrow indicates the test bench direction of travel relative to the sled table, passing underneath the side door structure. The mid-height arm rest foam condition is shown on the right.**

**Results**

***Intrusion in child passenger deaths in NSW***

There were 64 child deaths in passenger vehicles over the data period. In 29 cases (26 crashes), the child was in a restraint appropriate for the child’s age with no evidence of misuse. Of these 26 crashes, the primary area of damage to the vehicle was the side in 18 (69%), with intrusion into the occupant space a primary contributor to the child’s death in 17. The age range (median) of the child passenger was 1-11 (8) years and they were restrained most commonly with an adult seat belt (16), followed by booster (6), forward facing child restraint (4), rear facing child restraint (2) and unknown (1). Head injury was the most common cause of death (23/29), present in 16/19 (84%) children involved in 17 side impact crashes where intrusion was the primary contributor to death.

***Booster seat performance and intruding door shapes***

Different intruding door shapes influenced head injury risk (indicated by the Head Injury Criterion) with the medium sized armrest providing the highest risk and no armrest condition providing the lowest risk, see Table 1.

**Table 1. Head impact response of the Q6 dummy**

	Peak X head acceleration (g)	Peak Y head acceleration (g)	Peak Z head acceleration (g)	Head Injury Criterion
<b>No armrest</b>	-20.8	-106.4	33.0	933
<b>Low armrest</b>	-20.6	-132.4	35.8	1123
<b>Medium armrest</b>	-23.5	-221.9	48.9	1420
<b>High armrest</b>	-18.7	-157.0	37.5	1166

## Conclusions

Intrusion into the occupant space in a side impact crash appears to be the most significant factor related to child passenger deaths when children are appropriately and correctly restrained. This laboratory testing indicates the design of the side door structure influences injury risk in an intruding door side impact, likely due to changes in booster seat and occupant kinematics caused by impact against the differing door structures. Potential countermeasures include optimizing child restraint systems and their compatibility with vehicle door structures (in terms of impact points and corresponding stiffnesses), including integration with other safety systems such as airbags. This work represents a first step in understanding how this might be achieved.

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## The urban road and street design guide

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### Abstract

What do safe urban streets look and feel like? The Victorian Department of Transport (DoT) is developing the *Urban Road and Street Design Guide*, a design guide for urban roads and streets to help answer this question. The project is a powerful opportunity to align the Department's Movement and Place Framework with safe systems thinking. Lead consultants Arup alongside Gehl have prepared planning and design advice to help practitioners achieve a vision for safe, connected, vibrant urban roads and streets for people to live, work, move, play and stay. The guide takes a Complete Streets approach to planning, designing and delivering transport in Victoria. It puts people first, emphasizing the importance of safe access for all road users. This perspective means that safety is fundamental to any good street design. The project provides a toolbox to better understand and visualize what safe systems looks like in urban contexts and supports practitioners to implement nuanced, practical solutions.

### Background

As part of their *Movement and Place Framework* DoT recognized that a new approach is needed to enable and encourage practitioners to put people and their safety first and design solutions that responds to land use and network contexts. While many standards and guidance exist, there is no mechanism resolve the inherently conflicting nature of complex urban streets or how safe systems fits within this.

### Description

*The Urban Road and Street Design Guide* is a high-level design guideline that helps practitioners make context-specific, integrated decisions around the design of roads and streets across Melbourne and regional Victoria. The project team developed the following:

- **Vision and Principles:** Collaboratively defined an overarching vision for Victorian roads and streets and 12 design principles through stakeholder workshops.
- **Users and Strategies:** Defined requirements for each user group and high-level strategy.
- **Towards Zero:** Explored how better street design can contribute to the prevention of death and serious injuries for all road users.
- **Road, Street and Intersection Types:** Collaboratively defined 16 Road and Street Types and 8 Intersection Types that cover the various urban road contexts using DoT's *Movement and Place Framework* as a basis for classification.
- **Design Guidance:** Drawing from global best practice (see evidence base) we graphically communicated the typical current conditions and key challenges of each typology, and how to transform them into best practice future states.

The design guidance provides clarity for practitioners on priorities in different contexts and provides a mechanism to make design trade-offs. It is not intended to be a prescriptive, technical manual, but demonstrate the overall vision for streets. The guide aligns Movement and Place with safe systems and work towards achieving *Towards Zero* objectives by encouraging the implementation of

infrastructure that eliminates the likelihood, severity and consequences of collisions. It defines a series of maximum design speeds based on survivable impact speeds for each typology (see Table 1).

**Table 1. Design Speeds**

<b>Desired Speed</b>	<b>Appropriate Location (Road and Street Types)</b>
<b>10km/h</b>	Shared spaces: City Hub, Laneway, Living Street, and Service Access Lane
<b>30km/h</b>	City Street, High Activity Street, Mixed Activity Streets, Interchange Street, Local Activity Street, Neighbourhood Street. Any street near schools / other major pedestrian destinations. Points of conflict with vulnerable people (crossings and intersections).
<b>40km/h</b>	Boulevard (city) and Residential Connector. Prefer 30 km/h for safety, unless crossings with speed platforms or physical features to secure speeds $\leq 30$ km/h that provide safe accessibility.
<b>50km/h</b>	Boulevard (Suburban), Commercial Access Road, Industrial Road
<b>&gt;60km/h</b>	Scenic Road, or Connectors with limited access. Urban freeways, safe crossings should be grade-separated or at intersections with local speed reduction.

Advice is underpinned by the belief that streets should be designed aligning the design speed with the desired speed for a road safety outcome. On existing streets with excessive speeds, traffic calming measures should be used to reduce speeds to improve safety and comfort for all users. The Guide illustrates how various design controls can support safety including speed humps, chicanes, kerb extensions, materials, forward visibility, lane widths, roundabouts, pinch points, street trees, two-way streets, etc.

### **Evidence base**

To develop this guideline, the project team worked closely with stakeholders across various organisations and disciplines including practitioners, industry experts and advocacy groups. This included representatives from the Victorian DoT (including former VicRoads), DEDJTR, DELWP, TAC, VPA, MAV, DCP, RACV, ARRB, OVGA, MTIA, Bicycle Network and local councils. Stakeholders provided input through a series of workshops in two sprint periods. Additionally, content was pressure tested by a Technical Reference Group. Alongside stakeholder engagement, the guide draws on learnings from global and local best practice design and adapts advice to the Victorian context. This includes the NACTO guidelines, Auckland Road and Street Guide, the Crow Manual, New York Street Design Manual, Toronto Complete Streets Guideline and AustRoads Towards Safe System Infrastructure.

### **Next Steps**

The draft document was been submitted to the DoT in July 2020. The final draft will be released in 2021 and it will undergo a process of feedback, consultation and refinement.

## **Construction Logistics and Community Safety Australia (CLOCS-A): Progress Towards Safer Outcomes for Vulnerable Road Users**

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<sup>d</sup>Monash University Institute of Transport Studies

### **Abstract**

Currently across Australia, \$55 billion worth of transport infrastructure projects are under development in the urban centres of major cities. These projects will significantly increase heavy vehicle movements and as a result exposure to vulnerable road user interactions raising the need for action to improve safety outcomes for vulnerable road users (VRUs). International best practice is recognised as Transport for London's (TfL) Construction and Logistics in Community Safety (CLOCS) and action is underway to adapt the CLOCS approach in Australia. This paper will present the results of the initial phase of Construction Logistics Community Safety Australia (CLOCS-A) (due to be completed in June 2020) and explore how these projects, and smaller state projects, are adapting the standards to protect vulnerable road users, where and why variances are occurring, what barriers are emerging and the path towards an Australian adapted CLOCS program.

### **Background**

Over the next decade, Australia will undergo an unprecedented \$55 billion major city infrastructure build with potential for \$30 billion in additional funding projected. The construction activity associated with these major projects will generate a significant increase in the number of heavy vehicles moving through metropolitan areas. Without a nationally consistent and structured safety intervention program, the increase in heavy vehicles from this construction activity may lead to a concurrent increase in fatalities and injuries of pedestrians, cyclists and motorcyclists, often collectively referred to as vulnerable road users.

In recent years, the United Kingdom (UK) faced the emergence of similar risks with a boom in city-based major infrastructure projects, in particular the €55 billion Cross Rail project led by Transport for London. Around this time, there were an increasing number of crashes involving cyclists and heavy goods vehicles. In 2013, 14 cyclists were killed in London including 6 cyclists killed in a two-week period in November and 9 of the fatality crashes in 2013 involved a heavy goods vehicle (BBC News, 2013). There was a recognition from both the government and the construction industry of the need for action to improve the safety of interactions between construction trucks and vulnerable road users (CLOCS, 2018).

In response, a program known as Construction Logistics and Community Safety (CLOCS) was developed. Leadership for CLOCS in the UK came directly from the Mayor of London and the program's development was entirely funded by Transport for London (TfL) in collaboration with the construction industry and strong support from the community. CLOCS is recognised as world's best practice in protection for VRUs and has become the UK's safety standard in this space. Tangible benefits have been practically demonstrated also, with one authority achieving a 47% reduction in collisions and complaints following the introduction of CLOCS (CLOCS, 2018).

### **Changes in the Australian context**

The current National Road Safety Action Plan 2018-2020 requires contractors on government-funded construction projects to improve the safety of vulnerable road users around heavy vehicles through safety technology and education programs (Transport and Infrastructure Council, 2018). The recent

modifications of Chain of Responsibility within Heavy Vehicle National Law has strengthened the case for government funded projects to support CLOCS within Australia. However, there is still notable hesitation to supporting a national program due to possible increases in contract costs despite the demonstrated and independently evaluated risk reduction and industry costs savings in the UK.

Two of Australia's largest transport projects, Sydney and Melbourne Metro, have acknowledged the CLOCS standards and have partially adapted them to their project contracts. In 2017, Melbourne Metro Rail in conjunction with ARRB's National Road Safety Partnership Program (NRSPP) signed a Memorandum of Understanding with TfL which allowed for the complete sharing of all content relating to CLOCS.

### **Next steps in Australia**

In February 2019, ARRB and the NRSPP, secured \$100,000 in seed funding from the Commonwealth National Heavy Vehicle Regulator (NHVR) Funding Round 3 Safety Initiative to adapt the CLOCS program to Australia, to be known as Construction Logistics and Community Safety – Australia (CLOCS-A). The seed funding is viewed as the establishment phase which is due to conclude in June 2020 and is expected to include:

- Scoping and industry consultation
- Outline for Program Governance and Technical Groups
- Establishing champions to drive CLOCS-A

Presentation of this paper will include an opportunity for conference delegates to engage in a conversation about any potential barriers to applying CLOCS-A in Australia and how those barriers might be overcome. Also, to explore attitudes across various jurisdictions towards safety and duty of care in relation to the construction of these projects.

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## On-road driving errors in Mild Cognitive Impairment

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<sup>b</sup>School of Optometry and Vision Science, Queensland University of Technology, Brisbane, Australia

### Abstract

Dementia increases the risk of unsafe driving in older adults, but this is less apparent in pre-clinical stages such as mild cognitive impairment (MCI). There is a lack of detailed data on driving error patterns associated with MCI. We recruited older drivers from the community who completed a neuropsychological test battery and an on-road driving assessment. Compared to safe drivers classified as cognitively normal (CN) (n=242), safe MCI drivers (n=45) showed no difference in the rate of errors in different traffic contexts or error types. Unsafe CN drivers (n=17) made more errors in observation, speed control, lane position, and stop/give-way signs. Unsafe MCI drivers (n=9) had additional difficulties at intersections, roundabouts, and under self-navigation conditions. Unsafe drivers with MCI have difficulties under more cognitively demanding conditions, consistent with the increased rate of multi-domain type MCI found in this group.

### Background

Drivers with dementia have ten times the risk of failing an on-road driving test relative to healthy older drivers (Chee et al., 2017), however, the evidence for driving impairment in pre-clinical stages of dementia are mixed (Frittelli et al., 2009). Data on the types of driving errors observed in MCI suggest a similar pattern to that in CN older drivers, albeit more severe (Devlin, McGillivray, Charlton, Lowndes, & Etienne, 2012). We recently found no difference in the range of overall driving safety levels among CN and MCI drivers (Anstey, Eramudugolla, Chopra, Price, & Wood, 2017). Given the sparse data on how MCI impacts driving skills, and the potential for this group to benefit from tailored interventions, we examined the error patterns in MCI in more detail.

### Aim

To compare the types of errors incurred during an on-road driving assessment between safe and unsafe older drivers identified as either CN or MCI.

### Method

Licensed older drivers were recruited from the community between 2013 and 2016 in Canberra. Drivers completed a neuropsychological test battery and a validated, standardized on-road driving assessment on an urban route in a dual-brake vehicle with a driver-instructed component as well as a self-navigation component (Mallon & Wood, 2004). The driving assessor was blind to the cognitive skills of the participants. MCI status was determined using an algorithmic approach and IWG criteria (Winblad et al., 2004). Of 296 cases without dementia, 54 met criteria for MCI and 242 were classified as CN. Traffic context of errors and errors in lane position, observation, blind spot checks, indication, speed control, gap selection and approach were each recorded as a proportion of opportunities.

### Results

Of the 242 CN drivers, 17 (7%) were classed unsafe, and of the MCI drivers 9 (17%) were classed unsafe. Multinomial logistic regression models compared unsafe and MCI-safe drivers against CN-safe drivers on the rate of each error type, adjusting for age, gender and education. No differences

were found in the rate of errors at different traffic situations between CN-safe drivers and MCI-safe drivers, and no differences were found in error types. CN-unsafe drivers had higher error rates at stop/give-way signs, lane changes, curved driving, school zones (all  $p < 0.01$ ), and pedestrian crossings ( $p = 0.02$ ). MCI-unsafe drivers were similarly impaired at these traffic contexts, but had additional difficulties with straight driving ( $p < 0.001$ ), parking ( $p = 0.01$ ), and both controlled, and uncontrolled intersections ( $ps < 0.01$ ). CN-unsafe drivers had impaired observation, speed control, lane position, approach ( $ps < 0.001$ ) and gap selection ( $p = 0.02$ ) – mostly under driver-instructed conditions. MCI-unsafe drivers were also impaired in these skills, but had additional difficulties under self-navigation. Post-hoc binomial regression indicated no difference in amnesic MCI (OR=0.33(95%CI 0.04, 2.8),  $p = 0.31$ ), but greater odds of unsafe classification in multi-domain MCI (OR=6.32(95%CI 1.4, 29.6,  $p = 0.02$ ).

## Conclusions

Safe drivers with MCI do not differ in their on-road error profile relative to CN safe drivers. Unsafe drivers with MCI had additional difficulties in cognitively demanding and self-directed conditions. This may reflect the greater odds of unsafe driving in multi-domain MCI.

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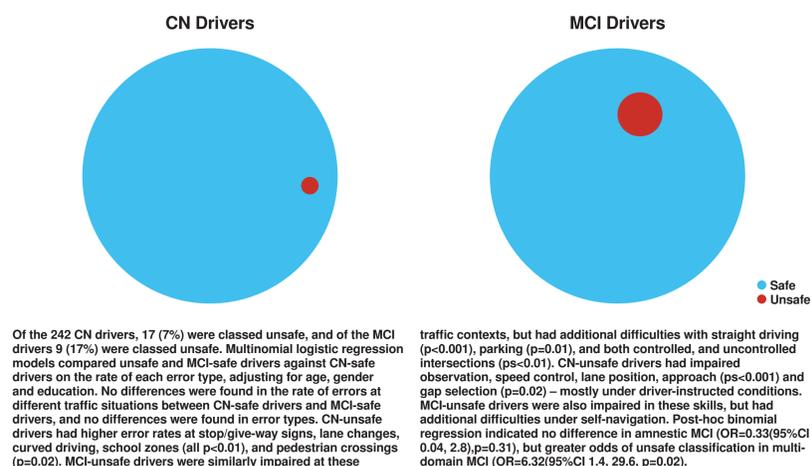
RANMALEE ERAMUDUGOLLA,  
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 KAARIN J ANSTEY

# ON ROAD DRIVING ERRORS

# IN MILD COGNITIVE IMPAIRMENT

Dementia increases the risk of unsafe driving in older adults, but this is less apparent in pre-clinical stages such as mild cognitive impairment (MCI). There is a lack of detailed data on driving error patterns associated with MCI. We recruited older drivers from the community who completed a neuropsychological test battery and an on-road driving assessment.

Compared to safe drivers classified as cognitively normal (CN) (n=242), safe MCI drivers (n=45) showed no difference in the rate of errors in different traffic contexts or error types. Unsafe CN drivers (n=17) made more errors in observation, speed control, lane position, and stop/give-way signs. Unsafe MCI drivers (n=9) had additional difficulties at intersections, roundabouts, and under self-navigation conditions. Unsafe drivers with MCI have difficulties under more cognitively demanding conditions, consistent with the increased rate of multi-domain type MCI found in this group.



## **Cognitive Function and Driving Performance for Young Drivers: A Systematic Review and Meta-Analysis**

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### **Abstract**

Young drivers are still undergoing cognitive development at the time they begin driving. Little research synthesis on cognition and driving performance has been conducted for young drivers. A systematic review and meta-analysis on 18 studies examining cognition and driving for drivers between the ages of 15 and 25 was conducted. Results indicated a variety of cognitive domains have been examined in relation to a range of driving performance measures, however predominate focus has been on examining individual cognitive domains. Findings were varied with no single cognitive domain or test being found to consistently predict driving performance. Preliminary findings suggest that a composite approach with multiple domains might be suitable in this population to identify at risk young drivers. Similar to the older driver literature, this would allow for investigations of comprehensive cognitive models and potential applications of cognitive testing and training for young drivers to enhance safety.

### **Background.**

Globally traffic crashes are the leading cause of death for 15-25 year old's, making young drivers the highest at-risk cohort of drivers (World Health Organisation, 2018). It is well established that one of the contributing factors to young drivers' increased crash risk is due to their ongoing development of cognitive function occurring in adolescence and young adulthood (Mouloua et al., 2004). Studies have suggested that specific cognitive domains, such as executive function, predict driving performance in young drivers (Ross et al., 2014; Ledger et al., 2019). For older drivers (a population with comparable crash rates), research has demonstrated that cognitive function is a reliable predictor of driving performance, particularly when using a battery of cognitive tests across multiple cognitive domains (Bennett, Chekaluk & Batchelor, 2016). However, there has been little research to determine if a similar approach is suitable for young drivers, and if so, which cognitive domain/s might be the best predictors of driving performance. This review aimed to collate findings from studies of young drivers (15-25 years old) to determine the associations between cognitive function and driving performance.

### **Method.**

Studies published and available in Medline, PsychInfo, and Scopus as of December 2019 were included in the review. To be included in the review, studies needed to have a measure of driving ability, a measure of cognitive function and include only drivers within an age range of 15-25 years old. A meta-analysis examined the size of the relationship (Pearsons *r* correlations) between the different cognitive domains and driving performance. The potential moderating effects of different cognitive tests and driving performance measures were investigated.

### **Results.**

A total of 18 studies met inclusion criteria. The cognitive domains investigated across studies were executive function (55% of findings), attention (18%), visuospatial skills (10%), memory (5%) and cognitive status (2.5%). The driving behaviours investigated across studies varied with lane deviation the most common (42%), followed by speed (30%), crashes (10%) and overall driving (7%), with other additional measures only examined by single studies.

There was considerable variability in findings across all domains, test, and most driving behaviours, with no single cognitive domain consistently predicting any of the driving behaviours. Only three studies examined scores on composite batteries, and found that the composite batteries of tests consistently predicted a variety of driving behaviours (speed, lane deviation and overall driving).

Results of the meta-analysis to determine the size of these relationships is currently being analysed and will be presented at the conference.

### Conclusions.

No single cognitive domain or individual cognitive test consistently predicted driving performance in young drivers. Comprehensive cognitive models which integrate multiple cognitive domains across multiple tests, such as those used to assess older drivers, need to be examined in young drivers. This will enable a better understanding of the nature of the relationship between cognitive function and driving performance in this population. This research supports the call for a more holistic approach using cognition to predict young driving performance to identify at risk young drivers. This will enable development in education and training programs to improve outcomes of road and driver safety.

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## Evaluation of the NSW Motorcycle Graduated Licensing Scheme

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### Abstract

The New South Wales (NSW) Motorcycle Graduated Licensing Scheme (MGLS) implemented in 2009, introduced a two-year second provisional period (P2) and extension of existing restrictions. An evaluation of the NSW MGLS consisted of a best practice review, outcome and process evaluations. The NSW MGLS was found to closely align with best practice. Comparing relevant crash trends, a number of positive findings were observed for P2 riders. However, positive outcomes were not observed in all statistical comparisons undertaken. Process evaluation showed engagement processes for training providers had improved and training was viewed positively, though not always found to be delivered consistently.

### Background

The NSW MGLS prepares new riders to be safe and low-risk through experience, tests, restrictions and conditions. It was implemented in 2009 and introduced a two-year provisional (P2) period for riders aged under 25 years. Before 2009, provisional licensing consisted of a one-year period (P1) with alcohol, phone use and other restrictions. The P2 period extended the time these restrictions apply and introduced additional graduated speed restrictions.

Participation in the Motorcycle Rider Training Scheme (MRTS) is mandatory in most areas under the NSW MGLS. It was developed in 1990 to equip riders with required on-road riding skills. It comprises a pre-learner course and a pre-provisional (P1) course and assessment. All parts must be successfully completed to transition to a provisional licence. In areas deemed “undeclared”, locations not within 100kms of a MRTS provider, learners must instead successfully demonstrate their skills through a practical riding test.

### Methods

The NSW MGLS evaluation was commissioned by Transport for NSW from the Transport and Road Safety Research Centre and consisted of the following research streams:

1. Best practice review synthesising findings from recent literature and interviews with road authority representatives from all Australian jurisdictions.
2. Outcome evaluation using interrupted time series analyses (n=151) of linked hospital, crash, licence and registration data, to compare trends four years prior and seven years post MGLS implementation.
3. Process evaluation of the MRTS based on interviews and focus groups with NSW road authority and licensing representatives, motorcycle groups, MRTS providers, instructors, assessors and licence applicants.

### Results

The NSW MGLS was found to closely align with best practice except for components of on-road assessment for learner licensure and night-time riding restrictions. Key rider competencies acquired via the MRTS were also best-practice aligned, except for limited attention to higher level skills relating to on-road riding choices and on-road learner training and assessment.

Changed outcomes, in terms of P2-rider crash trends, suggest the MGLS has improved rider safety in NSW. Declines were recorded:

- for all quarterly casualty and serious injury crash rates for P2 riders, relative to riders at the same stage under the old licencing system (ie. in their first two years on a full licence).
- in all casualty crash rates for fully licenced riders who were licensed post 2009, suggesting a potential flow-on effect of more experience at this licensing stage following an extended P2 period.

However, not all statistical comparisons indicated positive outcomes. Additionally, data limitations meant conclusions could not be drawn regarding the impact of the MRTS in undeclared areas.

The process evaluation suggested recent improvements in engaging rider training providers, which has potential to improve quality and consistency of delivery. It also indicated the MRTS is viewed positively overall by stakeholders, but is not always consistently delivered as intended.

### **Conclusion**

The evaluation of the NSW MGLS suggests it is closely aligned to best practice and has improved rider safety in NSW, with some areas identified for improvement. In light of the findings, key actions to enhance the NSW MGLS and MRTS will be considered.

## The Relationship between Pedestrian Waiting Times and Illegal Crossing Behaviours at Signalised Intersections in the Sydney CBD.

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### Abstract

The aim of this study was to examine the relationship between Individual Waiting Times (IWTs), Maximum Waiting Times (MWTs; imposed by the pedestrian light) and illegal crossing behaviour at nine intersection crossings in the Sydney CBD. An observational study was conducted (1.5-hours in the morning over two weeks) and validated with complementary video footage. Of the 6,931 observed pedestrians, 13.5% crossed illegally. The key finding from this study was that longer MWTs were significantly correlated with an increase in illegal crossings. The average MWTs at signalised intersections was approximately 70% longer than the average IWTs for those pedestrians that crossed illegally. The findings of research suggest that one possible mechanism to reduce illegal pedestrian crossing behaviour could be by reducing the MWT at signalised intersections.

### Background

Within New South Wales, there were over 5,500 pedestrian-related crashes in metropolitan areas between 2013–17 and 69 pedestrian fatalities in 2018 (TfNSW, 2018). It is not uncommon to observe pedestrians crossing illegally, which contributes to these crashes. Personal characteristics (e.g. age, gender) of pedestrians crossing illegally have been studied previously (e.g. Brosseau et al., 2013; Dommès et al. 2015; Zhuang et al. 2018; Chen et al. 2017). Few studies, however, have examined the relationship between MWT (the time between the end of the green phase to the end of the red phase for a standard pedestrian signal) and illegal crossing behaviour. Brosseau et al. (2013) concluded that longer MWTs result in an increase in pedestrian illegal crossings. However, little is known about the relationship between how long pedestrians wait before crossing (i.e. IWT) and illegal crossing behaviour. The aim of this study was to examine the relationship between IWTs, MWTs (imposed by the pedestrian signal) and illegal crossings at nine intersections in the Sydney CBD.

### Method

A naturalistic observational study was conducted at nine signalised pedestrian crossings in the Sydney CBD, categorised into three groups: crossings with short MWTs (40–45s); moderate MWTs (46–55s); and long MWTs (>55s). Observations of pedestrian crossings were recorded manually by two observers, each using a custom-made Android app implemented on an iPad, and by recording video footage. Manual recordings were used to derive MWTs and pedestrian crossing counts, by signal phase. Data were collected between 9:30am–11:00am during non-rainy weekdays. Video recordings were used to verify the manual records and identify pedestrian characteristics (age, gender, pace) and the IWT. Exploratory and statistical analyses yielded answers to the key research questions for the study.

### Results

#### *Exploratory Analysis*

Overall, 6,931 pedestrians crossed during the Green Phase (86.5%), Flashing Red Phase (FRP; 5.48%) and Static Red Phase (SRP; 8.02%). The proportion of violations (13.5%) across the nine

observed intersection crossings ranged between 7.47% and 22.27% of which the three highest violation proportions occurred at intersections in the long MWT group. For all intersection crossings, a higher proportion of males (58–71%) violated, and the majority of pedestrians crossed illegally at walking pace (63–95%). ‘Young Adult’ (35–68%) and ‘Adult’ (24–57%) age groups were, proportionately, the greatest violators.

### ***Statistical Analysis***

A one-way chi-square revealed a statistically significant difference between the proportion of illegal crossings made in the long MWT compared to the short and medium MWT groups,  $\chi^2(2, N = 853) = 45.75, p < 0.00$ . Further, based on the signal phase (FRP and SRP), a two-way chi-squared revealed that pedestrians were significantly more likely to cross during the FRP at locations with short MWTs, and during the SRP at longer MWTs,  $\chi^2(2, N = 853) = 80.86, p < 0.00$ .

### **Conclusions**

Illegal crossing by pedestrians is a significant issue in the Sydney CBD and is likely contributing to pedestrian-related crashes. The findings from this study can be used to inform countermeasures for improving pedestrian safety in the Sydney CBD, such as reducing the MWT at pedestrian signalised crossings.

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## **Impacts of speed limit changes on road safety risks: A case study of urban streets in Thailand**

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### **Abstract**

According to the WHO's Global Status Report on Road Safety, Thailand is among the top countries with highest traffic fatality rates. One contributing factor is the speed. The speed limit in Thailand is generally set at 80 km/hr for urban areas and 90 km/hr for roads outside built-up areas. Such figures are considered high and pose potential risks to road users. This study investigates potential impacts of speed limit changes. The International Road Assessment Programme (iRAP) star rating was utilized to investigate road safety in terms of risk scores for vehicle occupants, motorcyclists, and pedestrians. A total of 20 urban roads with different geometry and characteristics were selected from two cities in Thailand, namely, Bangkok and Phitsanulok. Sensitivity analysis results revealed that to achieve the target of 3-star or better roads, current speed limits need to be altered. Appropriate speed limits were also recommended for urban roads with different settings.

### **Background**

According to the WHO's Global Status Report on Road Safety, Thailand is among the top countries with highest traffic fatality rates. The latest figures reveal a fatality rate of 22,491 per year, of which up to 85 percent were pedestrians, bicyclist, and motorcyclists (WHO, 2008). One contributing factor is the speed. From the current road traffic regulation in Thailand, speed limits for passenger cars can be generally classified into two categories, i.e. 80 km/hr for urban areas and 90 km/hr for intercity roads and outside built-up area (Road Traffic Act, 1979).

It is known that higher speed would result in a higher fatality; thus, the current posted speed limits in Thailand appear to be too high particularly for urban streets and pose potential risks to road users of all types. This study attempts to determine potential impacts of speed limit changes.

### **Method**

The International Road Assessment Programme (iRAP) star rating was utilized to investigate road safety in terms of risk scores for vehicle occupants, motorcyclists, and pedestrians. A total of 20 urban roads with different road geometry and traffic characteristics were selected from two cities in Thailand, namely, Bangkok and Phitsanulok. All necessary road attributes were collected and coded according to the iRAP coding manual (iRAP, 2009). The attribute data codings were then processed through ViDA, an iRAP online assessment software. Risk scores and star ratings for vehicle occupants, motorcyclists, and pedestrians can be computed. Subsequently, a sensitivity analysis was conducted by varying speed limits from 30 km/hr to 90 km/hr to investigate potential changes in risk scores and star ratings for urban roads with different settings.

### **Results**

Table 1 presents the overall assessment of urban roads in both cities. At present, with the current speed limit being set as high as 80 km/hr for urban streets, it was found that on average only half of

the roads were rated 3-star, while the majority of the roads are considered unsafe for motorcyclists and pedestrians, falling into 1-star and 2-star categories. A sensitivity analysis was performed for each of the roads, and later aggregated based on selected criteria. Figure 1 illustrates key findings. With the global road safety target to raise at least 75% of travel on existing roads to be on 3-star or better roads for all road users by 2030 (WHO, 2017), speed limits for urban streets in Thailand could be set accordingly for each scenario.

**Table 1 Star Rating results for all surveyed roads**

**(a) Phitsanulok**

Star Ratings	Vehicle Occupant		Motorcyclist		Pedestrian	
	Length (km)	Percent	Length (km)	Percent	Length (km)	Percent
5 Stars	0	0.00	0	0.00	0	0.00
4 Stars	0	0.00	0	0.00	0.5	3.40
3 Stars	6.0	40.82	3.2	21.77	0.1	0.68
2 Stars	5.1	34.69	7.4	50.34	1.0	6.80
1 Star	3.6	24.49	4.1	27.89	12.9	87.76
N/A	0	0.00	0	0.00	0.2	1.36
Total	14.7	100.00	14.7	100.00	14.7	100.00

**(b) Bangkok**

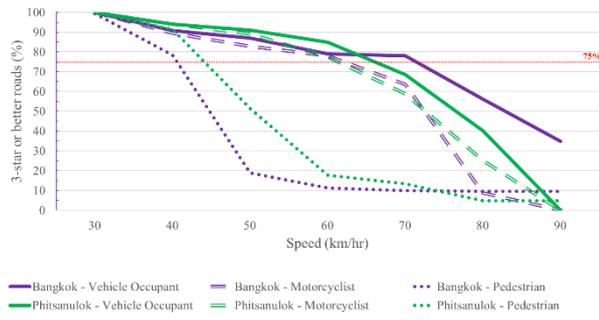
Star Ratings	Vehicle Occupant		Motorcyclist		Pedestrian	
	Length (km)	Percent	Length (km)	Percent	Length (km)	Percent
5 Stars	0	0.00	0	0.00	0.6	3.37
4 Stars	0	0.00	0	0.00	0.8	4.49
3 Stars	10.1	56.74	1.4	7.87	0.2	1.12
2 Stars	3.8	21.35	11.1	62.36	0.3	1.69
1 Star	3.9	21.91	5.3	29.78	15.9	89.33
Total	17.8	100.00	17.8	100.00	17.8	100.00

**Conclusions**

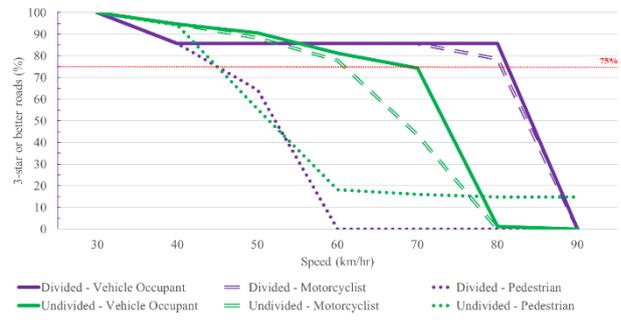
The present study attempts to illustrate potential reduction in road safety risks when speed limits are altered. Our empirical data showed that urban streets with similar geometry could result in different risks for different road user types. In addition, the sensitivity analysis revealed a reduction in unsafe road sections when speed limits were reduced. To set an appropriate speed limit for an urban street, one may consider the global road safety target as one of the criteria and implement it with a rigid traffic enforcement.

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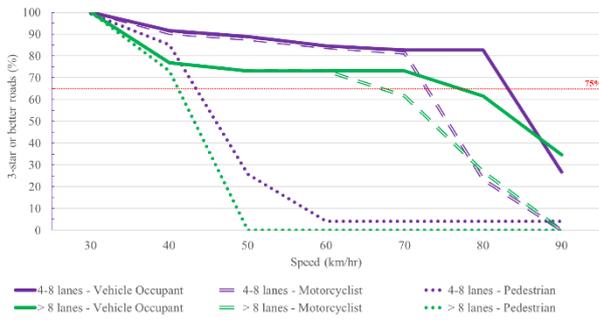
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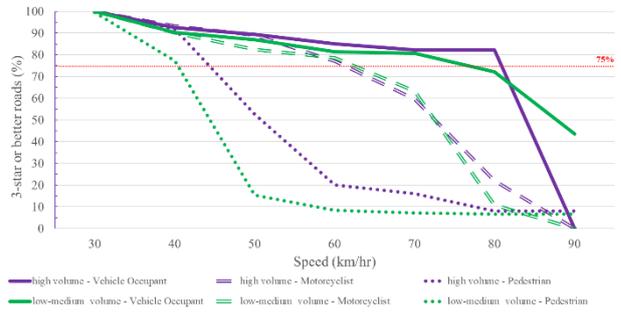
(a) City location



(b) Median type



(c) Number of lanes



(d) Traffic volume

**Figure 1 Sensitivity analysis results under speed limit changes**

## Understanding the Safety Impacts and Opportunities of New Zealand State Highway Resurfacings and Renewals.

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### Abstract

New Zealand generally experienced decreasing levels of road trauma (Deaths and Serious Injuries) up until the start of 2014, beyond which there have been four years of increases (2014-17) followed by a leveling off over the last two years. During the same period the maintenance regime, on the state highway network in particular, has also been revolutionized, with a reduced number of contracts, a change to a Network Outcomes Contract form, and a reduction, in real terms, of maintenance expenditure.

This study looked to determine if there have been any changes to the state highway network condition over the last decade, if there is any relationship between those changes and road safety, and what safety outcome improvements might be possible if maintenance efforts in resurfacing and renewals was increased.

### Background, Method, Results and Conclusions

Crash risk is influenced by a host of factors, of which driver and situational factors are perhaps most significant. However, this study focuses specifically on the impact of road condition on crash risk, variables that can be controlled by an informed road maintenance policy.

This study considered all rural State Highways in New Zealand excluding motorway sections and considered data collected between 2009 and 2018. The asset condition variables investigated were limited to those for which data was readily available, being skid resistance, texture, rutting, roughness and patching (routine maintenance).

There has been a considerable growth in state highway traffic 2009 and 2018, most of this growth taking place after 2013. The trends in road safety statistics closely reflect the traffic volume trends. The reversal of the decreasing crash rates around 2013/14 coincides with the increased growth in AADT. However, when the crash counts per year are normalized with traffic volumes, an increase in the crash rate is still visible. Thus, the increase in crash rates is not solely due to the increased traffic volume but is most likely influenced by many factors, including road condition

Whilst a large percentage of the rural State Highway network remains in a good condition. there is, for some of the condition indicators considered, a clear deterioration visible between 2013/14 and 2018. The age of road surfacings has steadily increased since 2014, together with this, and possibly related, the skid resistance deteriorated in terms of the percentage of the network with skid resistance below Investigatory Level (IL).

The study concurred with the findings of earlier research in establishing a significant link between road condition and crash rate. Skid resistance and road roughness, in particular, show a strong and statistically significant correlation with crash rate. Texture depth and the frequency of patching showed less clear but still significant relationships to crash rates.

The study included an analysis to assess the potential benefits of maintenance work to target deficient skid resistance. This analysis utilized and contrasted the observed crash rates on segments with poor and good skid resistance.

This study thus showed that:

- There has been a significant increase in crash rate from approximately 2013 to 2017, with a small improvement in 2018;
- There has been a significant increase in traffic since 2009 with a marked increase in traffic growth from 2013/14;
- Between 2013/14 and 2017/18, there has been a small but clear deterioration of the network in terms of almost all of the road condition indicators considered (surface age, roughness, skid resistance, texture depth, rut depth and patch frequency);
- There is an indisputable link between crash risk and road condition. This applies in particular to skid resistance and road roughness, and to a lesser extent to texture depth and patch frequency.
- The analysis of maintenance work impact on safety showed that, an overall benefit cost ratio of at least 2.5 can be achieved with certain combinations of curve radius and AADT yielding greater benefits than others, and benefit cost ratios greater than 10, at relatively small costs.

## Little Blue Dinosaur Foundation – Our Story – Prevention through Collaboration with Community Road Safety Stakeholders

Michelle McLaughlin<sup>a</sup>, David McLaughlin<sup>a</sup>, Richard Hunt<sup>a</sup>, Tony Nagy<sup>a</sup>, Liz McLaughlin<sup>a</sup>, Ben Wilson<sup>a</sup>

<sup>a</sup> Little Blue Dinosaur Foundation

### Abstract

Little Blue Dinosaur Foundation (LBDF) was established in 2014 in honour of Tom McLaughlin, aged 4 years who died in a pedestrian motor vehicle accident during a family holiday. In five years the Foundation have collaborated with 63 LGAs across 4 States to implement a cost effective child pedestrian road safety campaign designed to prevent trauma for very vulnerable road users. The Foundation have successfully gained five successive grants from Transport for NSW in the Community Road Safety Grant Program and campaign implementation has reached the target audience through stakeholder collaboration with Local Governments, State Governments, Police, Media, Schools and Members of Parliament. Featuring government endorsed messaging the key road safety education of the campaign aims to highlight importance of modeling safe road behaviour, working towards zero and draws on personal experiences of the impact of road trauma. Securing ongoing funding and resourcing will enable the Foundation to expand the campaign nationally.

### Introduction

BITRE data<sup>1</sup> from 2014-2018 note 196 fatalities of children aged 0-15 years from road trauma; 49 were pedestrian deaths. Confirmed by the Australian Institute of Health and Welfare<sup>2</sup> their updated data 17 Jul 2019 identified the most common cause of death for children aged 1-14 years as 'land transport' accidents.

The Little Blue Dinosaur Foundation's (LBDF) mission is to educate and protect child pedestrians from the ever-present danger of motor vehicles and roadways.

LBDF's "Holiday Time"/"Hold My Hand" child pedestrian road safety campaign utilizes colourful signage and educational resources, supported by a targeted LGA communications program to ensure core road safety message of "Slow Down Kids Around" and "Hold My Hand" resonate with road users.

Since piloting the campaign in 2014 with Central Coast Council, it has now been successfully implemented across 63 LGAs including 53 (48% of Councils) in NSW.

### Background

LBDF was established in 2014 in honour of Tom McLaughlin, aged 4 years who died in a pedestrian motor vehicle crash during a family holiday.

LBDF identified a 'gap' in road safety education during busy holiday times when families are out of their regular routines and known environments. The risks are further enhanced by the holiday destinations often lacking the traditional infrastructure to safely manage the seasonal spike in population.<sup>3</sup>

The campaign aims to highlight the importance of modeling safe road behaviour, working "Towards Zero" and draws on the personal experiences of direct impact of road trauma.

### Method

LBDF provides participating LGAs with signage to install in critical locations for peak holiday season. Signage installations are supported with launches featuring collaborative partners, media promotion, personal visits to the destinations and social media campaigns

Significant community engagement is achieved through the personal connections LBDF's CEO Michelle McLaughlin forges by relaying the personal impact of losing her son Tom McLaughlin to road trauma and the Foundation's desire to ensure such tragedies don't befall other families in the community – a heartfelt universal message that families can relate too.

## Results

LBDF's holiday campaigns have been successfully implemented with 63 LGAs with over 3000 signs. LBDF's social media platform has achieved a base of 5000+ followers and an annual reach of over 3 million.

LBDF's 2018/2019 summer campaign utilizing third party media achieved:

- Launch related coverage: 70 pieces – approximately 1.2 million reach
- Foundation related coverage: 62 pieces – approximately 6.6 million reach

From initial deployment with LGAs, LBDF's is now benefitting from expanding partnerships in tourism and retail sector including:

- Partnering with regional shopping centres
- Activating Outdoor advertising opportunities



## Conclusion

LBDF community road safety campaigns have achieved success from collaborating with different tiers of State Government and campaign implementation with Local Governments. The significance of LBDF achievement has been acknowledged through inclusion in NSW Road Safety Plan 2021.

Real life stories have significant community impact on behaviour modification. The power of a simple cost-effective community based campaign, with support and collaboration of our LGA partners cannot be underestimated in its worth and value.

LBDF faces the challenge of sustaining and expanding their campaign throughout Australia.

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4. Transport for NSW, Centre for Road Safety, NSW Road Safety Plan 2021, Page 14.

## Safe System Review of Fatal Crashes in the ACT

Gage Hodgson<sup>a</sup>, David McTiernan<sup>a</sup>, Puck Imants<sup>a</sup>, Anna Chevalier<sup>a</sup>

<sup>a</sup>Australian Road Research Board

### Abstract

The ACT Justice and Community Safety Directorate engaged the Australian Road Research Board to undertake a Safe System review of ten years of fatal crashes in the ACT. The review identified common fatal crash factors across Safe System pillars (roads, speed, vehicles, people, and post-crash care) based on crash data and reports from the Australian Federal Police and Roads ACT. The method developed allowed analysis of crash factors and identification of crash patterns to determine ‘gaps’ in the System that likely contributed to the cause and/or severity of each crash. Using this, countermeasures were developed to address these gaps across the Safe System pillars.

### Background

The ACT Justice and Community Safety Directorate sought to undertake a Safe System performance review of fatal crashes that occurred on the ACT road network over a ten-year period (2007-2016). The review covered an initial 114 fatal crashes that involved all road user groups.

Key aims of the study were to:

- Develop a method for evaluating fatal crashes that would assist identifying gaps in the Safe System approach to managing the ACT road network.
- Identify factors that contributed to cause and severity of fatal crashes broken down by Safe System pillar (roads, speeds, vehicles, people and post-crash response / care)
- Analyse the results of the Safe System review of ACT fatal crashes to inform the development of potential countermeasures to close these gaps, including infrastructure, road user education, policy and legislation

### Method

Crash data and reports for each fatal crash were received from the Australian Federal Police and Roads ACT. The crash data and reports for each fatal crash incident were reviewed by a team of road safety infrastructure and human factors experts to identify causal and severity factors contributing to each crash. These factors were categorised according to the Safe System pillars, including a proxy for post-crash care.

Contributing crash factors were analysed:

- Within each pillar to determine the common crash factors across the data set.
- By cross-tabulating various pillars to identify additional trends and links between pillars.
- To identify typical fatal crash profiles for each Safe System crash type.

Countermeasures were developed from the analysed results to address the identified Safe System gaps.

The bespoke database, crash factor coding, Safe System classification, and analytical methods developed during the crash review were based on a combination of road safety principals, existing crash dataset structures, previous studies, and project team experience.

### Results / Recommendations

Primary Safe System gaps and potential countermeasures for the five typical crash profiles are shown in Table 1.

**Table 1. Safe System gaps and potential countermeasures for typical crash profiles**

<b>Crash type</b>	<b>Primary Safe System gap</b>	<b>Potential countermeasure</b>
<b>Motorcycle (30%)</b>	Inexperienced riders	Improve rider training including graduated licensing scheme
<b>Run-off road (21%)</b>	Non-frangible roadside hazards	Review hazard locations with regard to clear zone and speed limit
<b>Intersection (19%)</b>	Older drivers 'looking but not seeing', or misjudging speed and distance	Review methods and procedures for ensuring fitness to drive
<b>Head-on (13%)</b>	Carriageways signed above Safe System speed for head-on collisions (70 km/h)	Reduce speed limit or consider need to separate carriageways (dual carriageway or median barrier)
<b>Pedestrian (12%)</b>	Speed limit exceeds Safe System speed for vulnerable road users	Reduce speed limit to 30 km/h in areas with high-pedestrian activity (commercial and retail districts, residential areas and areas with large numbers of child and elderly pedestrians)

Approximately 5% of crashes were considered atypical, and analysis did not reveal any patterns or trends within these crashes.

Other common factors identified across various crash types include:

- Increased severity for crashes where road users exceed Safe System speeds for the road environment
- Higher likelihood of younger male drivers being involved in a run-off road crash
- Drivers use of drugs and/or alcohol
- Older vehicles overrepresented across all crash types compared to age of entire ACT vehicle fleet
- Seagull intersections potentially exceeding safe traffic volume or speed

An additional outcome of this review was identifying the need for improved co-ordination and documentation of fatal (and serious injury) crashes, including identification of suicide crashes. It was concluded that such improvements would improve the efficiency and effectiveness of future Safe System assessments and provide road safety policy advisors and decision makers with a stronger evidence-based approach to developing holistic road safety strategies thus leading the way towards a zero death and serious injury future.

## **Injury risk and delta-V - insights from event data recorder information and reported injury outcomes**

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<sup>a</sup>Centre for Automotive Safety Research, The University of Adelaide

### **Abstract**

This study examined event data recorder (EDR) information downloaded from 316 vehicles involved in crashes in South Australia from 2017 to 2019 matched to police crash reports and hospital records. The EDR vehicles contained 421 occupants and, while 70% of EDR vehicle occupants sustained no injuries, 7% percent had minor injuries, 21% of occupants were treated at hospital and 2% of occupants were admitted to hospital. Higher injury severity outcomes occurred in head-on collisions, rollovers and single vehicle collisions with fixed objects. Delta-V was a good predictor of injury, and for all crash types, an occupant in a crashed vehicle experiencing a total delta-V of 40 km/h had an injury risk of 60%, more than double the injury risk for a crash with a total delta-V of 20 km/h. In side-impact collisions, injury risk was much higher; a lateral delta-V of 40 km/h corresponded to an 87% injury risk.

### **Background**

Since 2014, the Centre for Automotive Safety Research (CASR) has been routinely downloading event data recorder (EDR) data from the airbag control modules of vehicles involved in crashes as part of the in-depth crash investigation program (Doecke, 2017). Since 2017, CASR has been downloading EDR data on a larger scale at a crashed vehicle auction yard (Pickles Auctions Adelaide), obtaining police reports relevant to the crashed vehicles and synthesizing all relevant information into an EDR crash vehicle database. This allows for more in-depth quantitative insights into specific vehicle crashes which are generally not routinely available. The aim of this study was to examine the injury characteristics of occupants in EDR vehicles, in particular the relationship between delta-V and injury risk. Delta-V is a value which is calculated by the change of velocity of a vehicle during an impact and can be used as an indicator of the collision severity of a crash. Both longitudinal and lateral delta-Vs are monitored by the airbag control module so the appropriate airbags (frontal or side) are deployed when a threshold has been exceeded. These values are then stored on the EDR when a collision occurs.

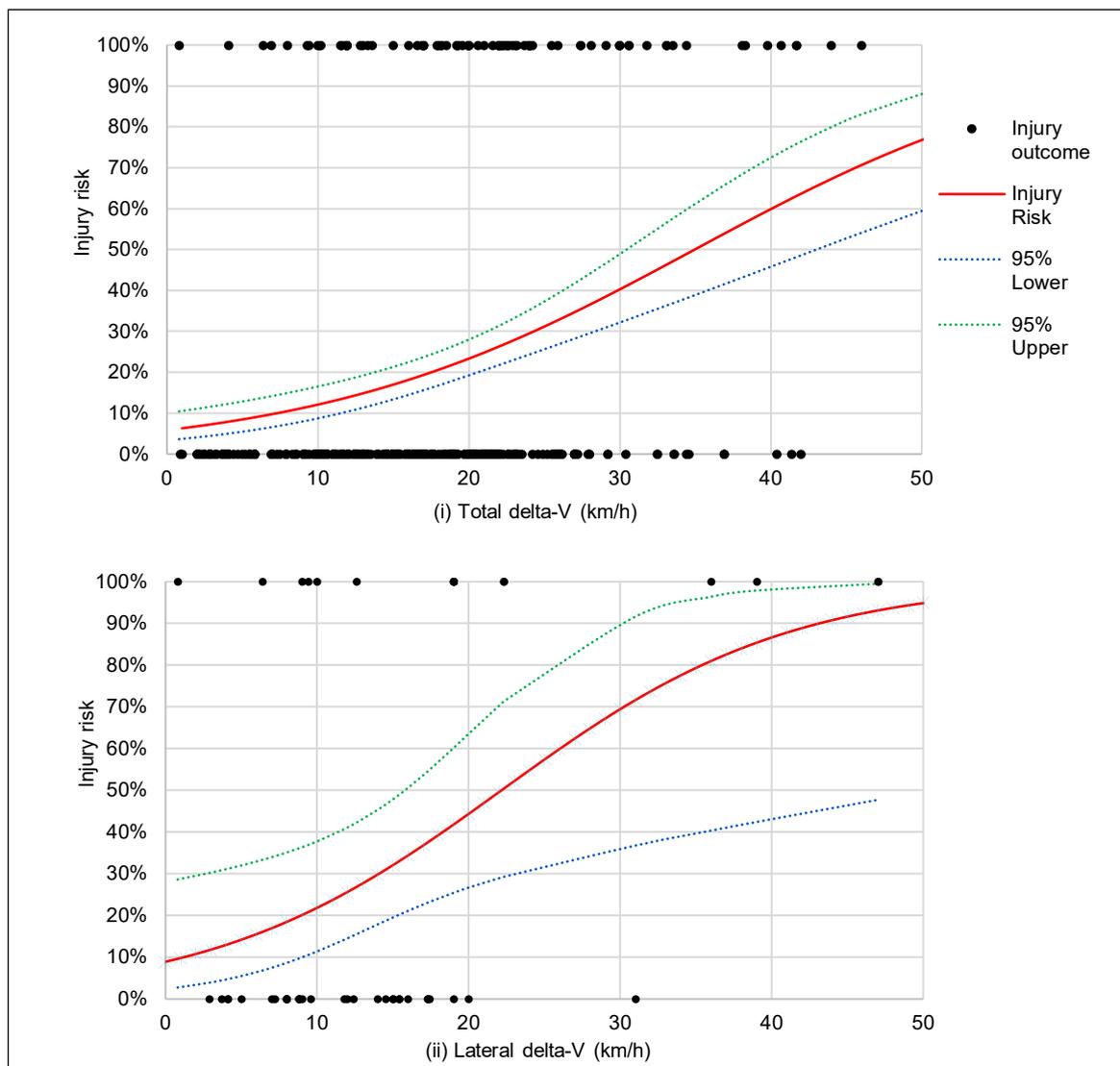
### **Method**

CASR researchers have been attending Pickles regularly throughout each year since 2017 and have downloaded EDR data from accessible, crashed vehicles, using the Bosch Crash Data Retrieval (CDR) tool. Measurements and photos of the vehicles were taken, and any police reports associated with the crashed vehicles were acquired and examined. Additionally, the hospital records of injured occupants were examined, and injuries coded according to the Abbreviated Injury Scale (AIS; Association for the Advancement of Automotive Medicine, 2005). Police reported injury severity was compared to EDR delta-V data for individual crashes and some analysis of AIS injuries was undertaken.

**Results**

In the period 2017-2019, EDR and police report data were acquired from 316 vehicles involved in crashes in South Australia. There were 421 occupants in these vehicles, of whom 70% sustained no injuries, 7% had minor injuries, 21% were treated at hospital and 2% of occupants were admitted to hospital. A logistic regression analysis was undertaken to predict injury severity; delta-V was the predictor variable and minor or no injury (outcome 0) was compared to treated or admitted to hospital injury (outcome 1) for the EDR vehicle occupants.

Total delta-V (calculated as the square root of the sum of the squares of the longitudinal and lateral delta-V) was found to be a reasonable predictor of injury for all crash types combined. A vehicle occupant in a crashed vehicle experiencing a total delta-V of 40 km/h had an injury risk of 60% (Figure 1(i)), more than double the injury risk for a crash with a total delta-V of 20 km/h (23.3% injury risk). In side-impact collisions, injury risk was much higher; a 60% injury risk was observed at a lateral delta-V of 26 km/h (Figure 1(ii)).



**Figure 1. (i) Total delta-V and (ii) Lateral delta-V and injury risk.**

Of the 96 vehicle occupants who were transported to a hospital, 38 hospital records were located, and occupant injuries were coded according to the AIS. Twenty occupants had no codable injuries, 14 had a maximum AIS 1 injury, 2 had a maximum AIS 2 injury and 2 occupants had a maximum AIS 3 injury.

### **Conclusions**

A relationship between delta-V and broad injury severity could be established, but, due to the small sample of occupants with a verified and coded injury, a relationship between delta-V and AIS injury severity could not be established. With a greater sample size and broader range of EDR-accessible vehicles, more accurate injury risk curves could be developed using EDR data and objective injury data.

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## Modelling the Potential Road Trauma Reductions of Mobile Phone Detection Cameras in NSW

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### Abstract

The Road Safety Plan 2021 details the New South Wales (NSW) Government's commitment to improve road safety, including initiatives to research and enable camera-based technology to enforce mobile phone offences.

In 2019 Transport for NSW (TfNSW) led a world-first non-enforcing pilot of fixed and transportable mobile phone detection cameras (MPDC), at locations across Greater Sydney. Monash University Accident Research Centre (MUARC) was engaged to estimate the potential reduction in road trauma from a proposed program of automated mobile phone enforcement.

Modelling estimated that a program that reaches 99.5% of the NSW driving population and achieves 30% to 40% deterrence could prevent approximately 95 to 126 fatal and serious injury crashes over five years, equating to savings of approximately \$126 million to \$168 million. The use of overt signage highlighting camera locations would reduce the benefit of the program by around 80 per cent.

### Background

In NSW since 2012, there have been over 182 casualty crashes, which resulted in 13 deaths and 243 injuries, where it has been established that a driver using a hand held mobile phone was involved in the crash. However, in the event of a crash, drivers may be motivated to conceal mobile phone use to limit penalties and liability, or unable to report mobile phone use (for example if seriously injured or killed). Accordingly, mobile phone use is under reported in established crash data and accurate estimates of prevalence amongst drivers are scarce.

NSW conducted a world-first non-enforcing pilot of automated MPDCs in 2019. The system uses artificial intelligence to analyse images, with only those likely to show a driver using a mobile phone subsequently reviewed by trained personnel, with controls to securely store and process images. Further information is available within the paper *Development of a world-first Mobile Phone Detection Camera Program, from no known solution, to an operational program in NSW Australia* (Australasian Road Safety Conference 2021). The pilot identified the prevalence of illegal mobile phone use on NSW roads to be 1.2 per cent at fixed enforcement locations, and 1.9 per cent at transportable locations (Wall et al, 2019).

All fine amounts from speed, red-light and mobile phone detection cameras go directly into the NSW Community Road Safety Fund, to deliver targeted road safety initiatives in NSW.

### Method

Estimating the potential reduction in NSW road trauma from a program of fixed and automated mobile phone enforcement requires understanding of several factors relating to drivers' illegal mobile phone use and the risk associated with that activity, the number and cost of crashes, and details of the proposed program.

Table 1 lists the required inputs, specific estimates used and data sources.

**Table 1. Required inputs and sources for calculating potential trauma reductions of automated mobile phone camera enforcement**

Information required	Specific data used	Data sources	Estimate		
Prevalence of illegal mobile phone use	Prevalence in NSW drivers	NSW MPDC trials	Fixed camera locations: 1.2% Transportable camera locations: 1.9%		
Crash risk associated with illegal mobile phone use	Odds ratio	SHRP 2 (Owens et al., 2018)	Odds ratio=1.83		
Proposed program reach	Proportion of drivers exposed to MPDC	ABS <sup>1</sup>	99.5% of NSW population live in areas that will be covered using MPDC		
Expected deterrent effect	% of NSW drivers who will be deterred	NSW CRS <sup>2</sup> , based on NSW speed camera compliance	30% to 40%		
Current size of road trauma problem in target areas	Average annual number of crashes in NSW (excluding areas not covered by the proposed program), by severity	NSW CRS crash data (2012-17)	Crash severity	Metro	Rural
			Fatal	87	233
			Serious injury	2,650	2,350
			Moderate injury	4,532	3,801
			Minor/other injury	3,688	1,614
			Total casualty	10,957	8,006
Average crash costs (2018 dollars)	Inclusive Willingness to Pay costs per crash, by severity	Transport for NSW (2018, Table 54, page 277)	Crash severity	Metro	Rural
			Fatal	\$7,653,597	\$9,058,911
			Serious injury	\$497,393	\$686,163
			Moderate injury	\$83,423	\$110,188
			Minor/other injury	\$76,668	\$101,259

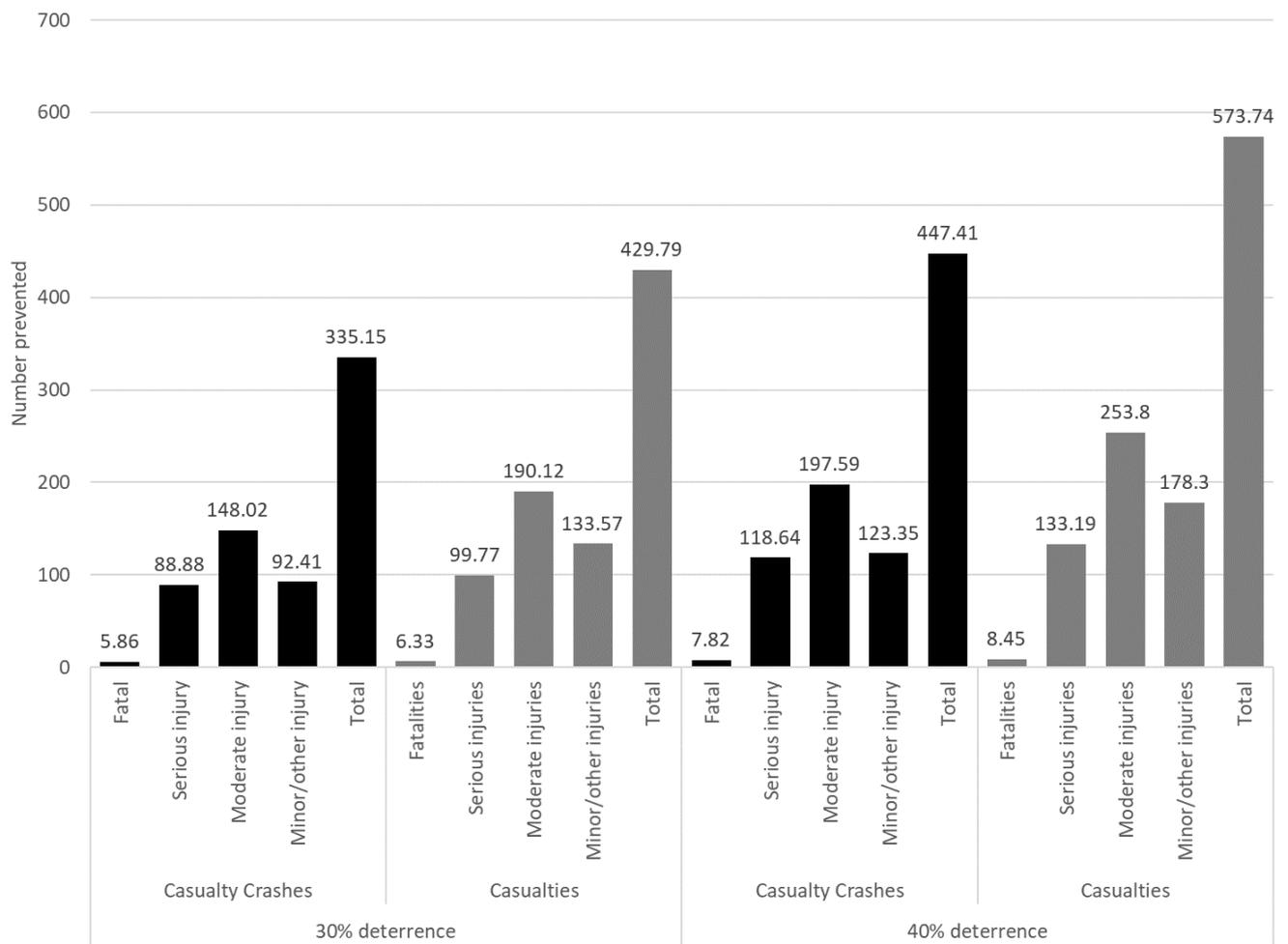
The proportion of crashes that could be prevented by eliminating illegal mobile phone use was calculated using the Population Attributable Fraction (Hennekens & Buring, 1987). Adjustments were made to account for program reach and likely deterrence.

## Results

Modelling estimated that a program that reached 99.5% of the NSW driving population and achieved 30% to 40% deterrence could prevent approximately 95 (30% deterrence) to 126 (40% deterrence) fatal and serious injury crashes over five years (Figure 1), equating to savings of approximately \$126 million (30% deterrence) to \$168 million (40% deterrence). The use of overt signage highlighting camera locations would reduce the benefit of the program by around 80 per cent.

<sup>1</sup> Analysis of population levels in areas of NSW, drawing on 1270.0.55.005 - Australian Statistical Geography Standard (ASGS): Volume 5 - Remoteness Structure, Australian Bureau of Statistics, July 2016

<sup>2</sup> NSW Centre for Road Safety



**Figure 1. Estimated number of casualty crashes and casualties prevented by the mobile phone detection camera program in NSW, over 5 years**

**Conclusions**

The modelling identified that a MPDC program in NSW could achieve substantial crash and cost savings, but signage at camera locations would significantly reduce those savings.

The identified road trauma reductions were a key consideration in the NSW Government’s decision to implement a MPDC program in NSW, as one component of the strategy to reduce road fatalities and serious injuries by 30 per cent by 2021 (compared to 2008-10 levels), and to zero by 2056.

As of December 2019, NSW was the first jurisdiction in the world to establish such a program.

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## **Determining the readiness of road line markings for autonomous vehicles through custom video analysis software**

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### **Abstract**

Two vehicles equipped with lane support systems (lane departure warning and lane keep assist) were instrumented with a GPS receiver and video cameras to record the detection rate of road line markings along an approximately 80 km route. Custom video analysis software was developed to determine the locations of line marking detections made by the vehicles post testing. An overall 97.8% detection rate was observed along the selected route, and the locations of the non-detections were further analysed to indicate possible causes of non-detections. Both lane support systems tested showed similar results for overall distances of line markings detected, but differences in the frequency of non-detections were reported.

### **Background**

The readiness of road line markings for autonomous vehicles is dependent on whether vehicles can correctly detect line markings. Lane support systems (LSS) in vehicles, such as lane departure warning (LDW) and lane keep assist (LKA) systems, provide warnings and assistance to drivers when their vehicle crosses or drifts towards a line marking on the roadway. Several studies have investigated the effectiveness of LSS in preventing crashes. Jermakian (2011) estimated a mitigating effect in 10% of single vehicle injury crashes, 35% of head-on injury crashes, and up to 33% of sideswipe injury crashes for vehicles with LSS, while Scanlon et al. (2015) predicted a 27.8% effectiveness in mitigating injuries across similar crashes for rudimentary LKA systems. Sternlund et al. (2017) concluded that vehicles equipped with LSS were 53% less likely to be involved in a casualty crash. LSS use front facing cameras, along with image processing algorithms, to detect the presence of line markings and, in some cases, display the results on the vehicle dashboard. The aim of this study was to create a process to safely determine the readiness of road line markings using vehicle dashboard displays.

### **Method**

Two vehicles (2018 Toyota Corolla and 2018 Mazda CX-9) equipped with LSS were instrumented with a GPS receiver, a video camera to record the dashboard display and another video camera to record the front view of the vehicle while travelling both directions along a popular holiday route in South Australia, from Port Noarlunga to Victor Harbor (roughly 80 km round trip) during dry, sunny weather conditions.

Custom video analysis software was developed to determine the locations where the LSS detected line markings on either side of the vehicle. Lane changes and periods where travel speeds were less than 60 km/h were removed from the analysis as the LSS disengaged in such scenarios. A common driver was used, who set the speed of the vehicle with cruise control, but returned the vehicle to manual control when necessary.

## Results

The line marking detection results along the route were disaggregated for each vehicle and each side of the vehicles (edge lines and centrelines), as shown in Table 1. The Toyota Corolla LSS had an average detection rate of 97.2%, while the Mazda CX-9 had an average detection rate of 98.3%. The total count of instances of non-detections (defined as a continuous period where the line marking was not detected) were much higher for the Toyota at 147 compared to 24 for the Mazda. Overall, the average detection rate was 97.8%.

*Table 1. Line marking detection results for both vehicles disaggregated by line side*

	<b>Total distance (km)</b>	<b>Line markings detected (km)</b>	<b>Line markings not detected (km)</b>	<b>Percentage detected</b>	<b>Instances of non-detections</b>
Toyota edge lines	82.53	80.66	1.87	97.7%	52
Toyota centrelines	82.08	79.37	2.71	96.7%	95
<b>Toyota total</b>	<b>164.61</b>	<b>160.03</b>	<b>4.58</b>	<b>97.2%</b>	<b>147</b>
Mazda edge lines	81.89	80.60	1.29	98.4%	11
Mazda centrelines	81.90	80.48	1.42	98.3%	13
<b>Mazda total</b>	<b>163.79</b>	<b>161.08</b>	<b>2.71</b>	<b>98.3%</b>	<b>24</b>
<b>Overall total</b>	<b>328.40</b>	<b>321.11</b>	<b>7.29</b>	<b>97.8%</b>	<b>171</b>

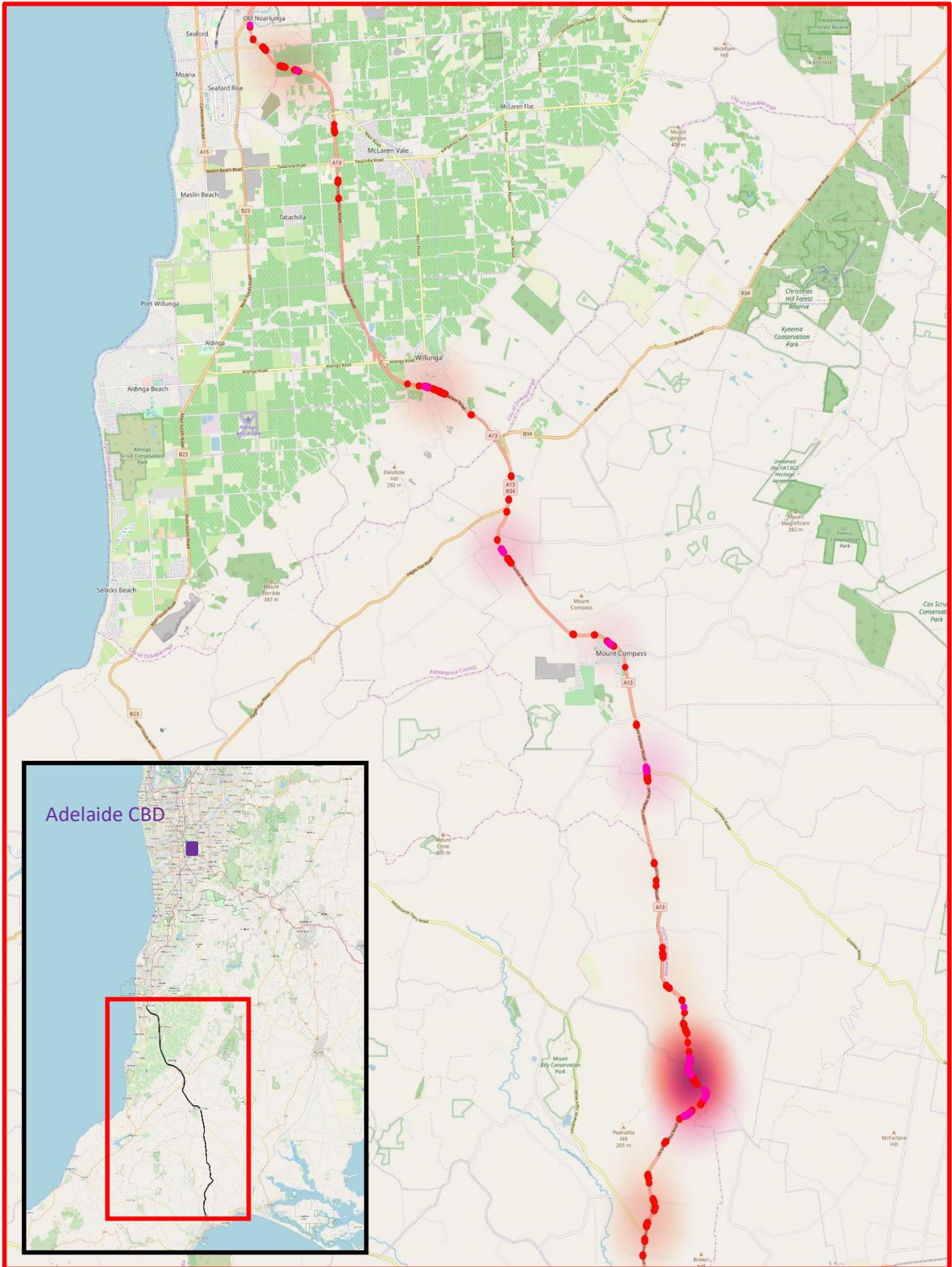
The locations of the non-detections and hotspots for non-detections are shown on a map in Figure 1. The video footage from these locations was analysed closely and potential causes for non-detection were identified, including:

- Use of a differing line marking technique (tactile bumps instead of painted lines),
- Non-continuous line markings,
- Introduction of turning lanes
- Absences of lines, and
- Shadows over line markings.

Further research could include expanding the routes taken to identify other line marking scenarios which are not detected by vehicles' LSS.

## Conclusion

The procedure to determine the readiness of line markings using a vehicle dashboard was successfully developed using custom video analysis software, indicating an overall 97.8% detection rate along the selected route. Several locations where non-detections occurred were identified, some of which may be suitable for remedy.



*Figure 1. Hotspots and locations of non-detections along route for both vehicles*

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## **A technical review of 40 km/h speed limits in the City of Charles Sturt local government area**

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### **Abstract**

A technical review was undertaken relating to the introduction of 40 km/h speed limits in certain areas within the City of Charles Sturt in South Australia. This involved the analysis of before and after traffic survey and crash data. Mean vehicle speeds decreased by 2.30 km/h, 85th percentile speeds decreased by 4.27 km/h, and weekday traffic volumes decreased by 7.4% in areas where the speed limits changed. Crash data was examined for equal periods before and after the 40 km/h speed limit changes and there was a 14.8% reduction in the number of casualty crashes on roads where the speed limit had been reduced from 50 km/h to 40 km/h, a 28.6% reduction in casualty crashes on roads that had a pre-existing (and retained) 40 km/h speed limit, and a 7.8% reduction in casualty crashes on Council-owned roads that retained a 50 km/h speed limit.

### **Background**

Road safety in local government areas is a significant challenge, and the City of Charles Sturt (CCS) Council in SA have demonstrated commitment through the introduction of 40 km/h area speed limits (40 areas) in several precincts across their road network. The lowering of speed limits across a large area of the road network is known to have an appreciable effect in terms of reduced travel speeds which, in turn, lead to a reduced number of crashes (Kloeden et al., 2007). While lower speed limits are demonstrated to be associated with improved road safety, it is important to periodically evaluate any safety initiatives to review the effectiveness within the transport system.

### **Method**

Traffic survey reports from sites where the speed limit had been reduced from 50 km/h to 40 km/h in recent years were analysed. At most sites, a survey report was available from both before and after the speed limit reduction and included 7-day average daily mean and 85th percentile speeds, as well as two-direction 7-day and 5-day traffic counts. There were 148 unique survey locations (Figure 1). To account for effects that may only influence traffic in particular directions, traffic volume and speed data were treated independently (where possible).

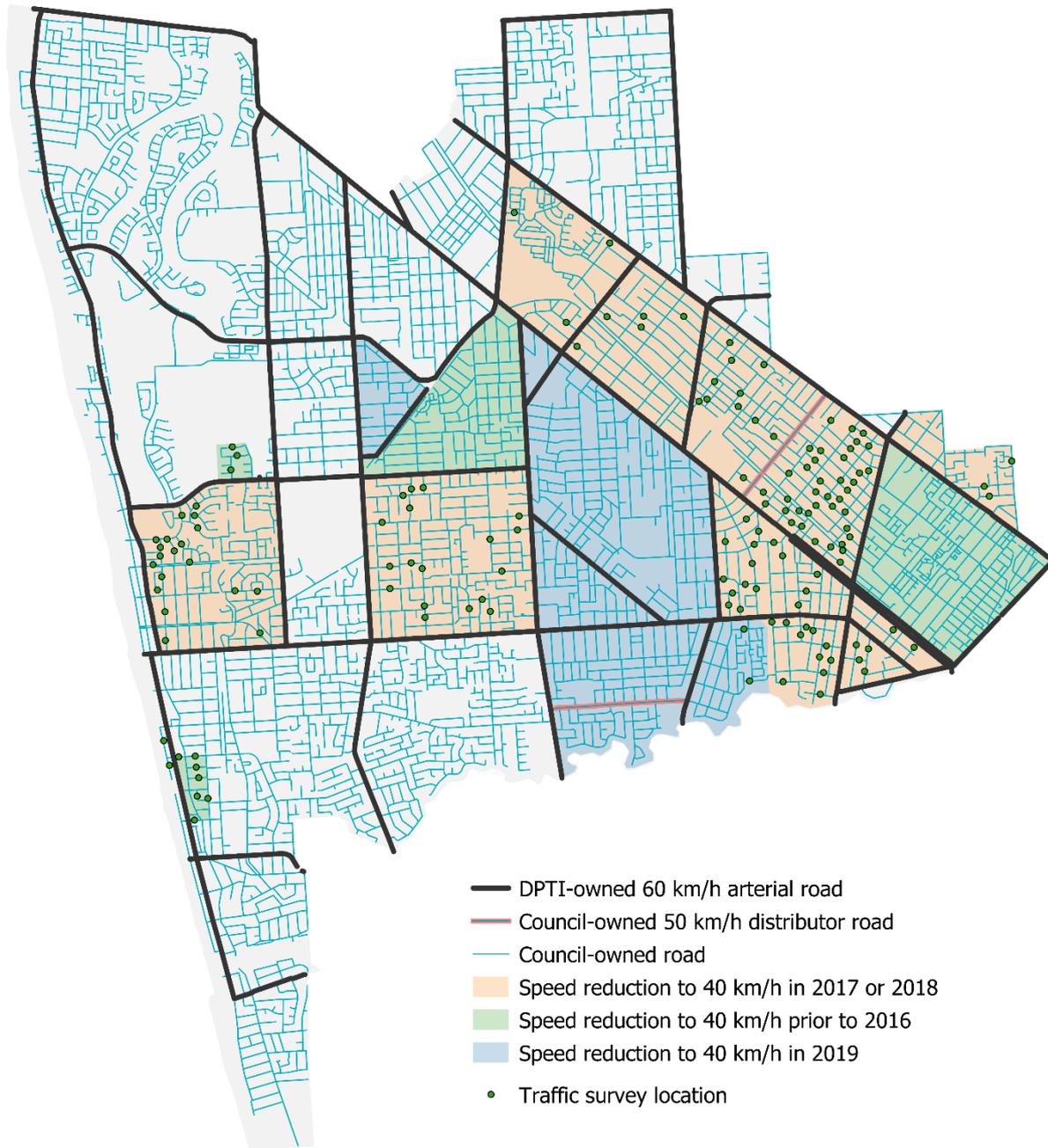
Crash data from equal periods before and after the implementation of the 40 areas were also extracted from the South Australia police reported database and analysed.

### **Results**

Analysis of the traffic survey data found statistically significant reductions of 2.30 km/h in mean speeds and 4.27 km/h in 85th percentile speeds associated with the introduction of the 40 areas. Average daily traffic volumes for 7-day and 5-day periods were found to have reduced by a statistically significant amount of 6.1% and 7.4% respectively. However, a sensitivity analysis found smaller reductions in the 7-day and 5-day traffic volumes of 3.3% and 4.1%, which may indicate that some traffic was affected by changes such as infrastructure developments. All traffic results are summarised in Table 1.

There were very few crashes on local roads in the City of Charles Sturt during the periods examined. Consequently, statistically significant changes in crash numbers were not able to be identified.

Nonetheless, there was a 14.8% reduction in the number of casualty crashes on Council-owned roads where the 40 areas were introduced, a 28.6% reduction in casualty crashes on Council-owned roads in existing 40 areas, and a 7.8% reduction in casualty crashes on Council-owned roads that retained a 50 km/h speed limit.



**Figure 1. Traffic survey locations**

**Table 1. Changes in traffic speed and volume as a result of speed limit reduction to 40 km/h**

<b>Analysis group</b>	<b>Result</b>
Mean speed before 40 area implementation	39.8 km/h
85 <sup>th</sup> percentile speed before 40 area implementation	48.0 km/h
Change in mean speed after 40 area implementation	-2.30 km/h *
Change in 85 <sup>th</sup> percentile speed after 40 area implementation	-4.27 km/h *
Change in 7-day volume after 40 area implementation	-6.1 % *
Change in 5-day volume after 40 area implementation	-7.4 % *

\* Statistically significant result

## Conclusions

The implementation of 40 km/h speed limits has resulted in an expected reduction in vehicle travel speeds and possibly a small reduction in traffic volumes. The effect of these speed and volume reductions on crashes was not able to be conclusively quantified, but the analysis indicates that crash reductions are similar to, or better than, those experienced in areas where speed limits did not change.

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## Identifying high-risk intersections by modelling driving behaviour with machine learning methodologies

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### Abstract

Finding patterns in driver behaviour around intersections using large telematics data combined with statistical crash records in a highly accurate and predictive intersection model can enable a more preventative data driven service that saves lives.

The Data Discovery Lab team within Enterprise Data and Analytics Services (EDAS), Transport for NSW recently examined the potential of using telematics data to identify high crash risk locations on NSW roads through Artificial Intelligence methodologies and Machine Learning algorithms. The methodology investigated the area in and around intersections accounting for information on driver behaviour obtained from telematics data as well as the statistical data recorded in previous years.

The study has examined telematics data from 55 light vehicles, approximately 35,000 unique trips, at around 5,000 intersections and 841 crash sites in the Wollongong area. The data was pre-processed and reduced for this study.

### Introduction

Transport analytics traditionally relies on statistics, dashboards and business intelligence tools to deliver insights on crash risk based on crash data. In this study a fresh approach has been adopted which is based on crash risk analysis to identify potential risk of a crash.

A hypothesis was proved that the drivers' behaviour around High Risk Intersections are different to that of a non-High Risk Intersections investigating speed, harsh breaking, harsh cornering and rapid acceleration events using a two dimensional classification Machine Learning model.

### Methods

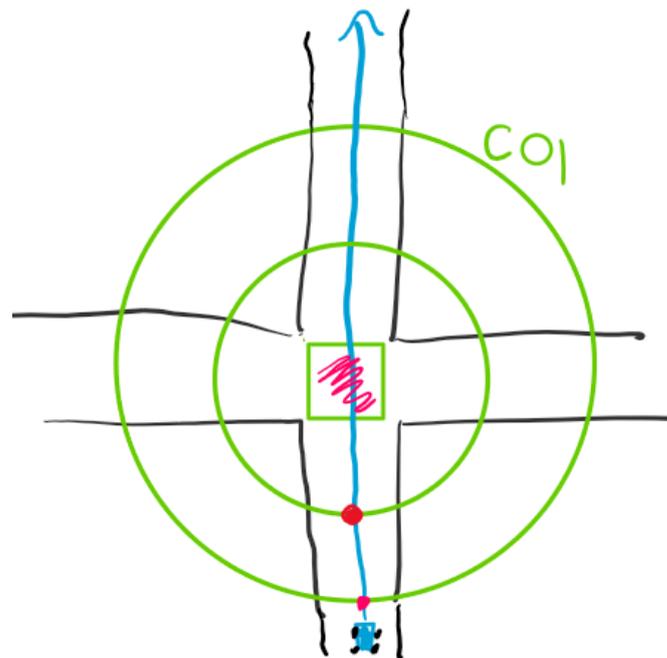
The following datasets are used in the study:

- Telematics data collected from 50 vehicles in the Cooperative Intelligent Transport Initiative (CITI) project conducted by the Centre for Road Safety (CRS), Transport for NSW. The telematics devices are fitted to participants' vehicles, including an accelerometer, recording data at 40Hz, collected for a year.
- Intersection Risk Model (developed by CRS to classify intersections by the severity of accidents and other risk factors)
- Relevant statistical crash data in the area
- A table that includes all intersections' GEO location

The non-traditional method to investigate all this information and process the data was a unique approach.

To be able to run Machine Learning algorithms on this dataset, the team went through an extensive data mining strategy, processing more than 1 terabyte of data points.

Engineered tables were created that synergised all the calculations from the driver behaviour around intersections within a defined Circle of Interest (CoI) (see Figure 1),



**Figure 1. Circle of Interest around the Intersection**

The table below shows the predictor (independent) variables and the predicted (dependant) variable used in this preliminary analysis to identify intersections that were not previously classified as high-risk using traditional methods.

The model was trained and tested in a traditional Machine Learning approach using supervised learning with a 80/20 split using the predefined and pre-classified High Risk Intersections.

Table 1. demonstrates the profile of the intersections (1 intersection per row) that aggregated from all the information from the datasets (independent variables), including number and severity of crashes, harsh acceleration and cornering, speed at the border, midway and passing through the Next Closest Intersection (NCI calculated from each trip) and the number of trips. By applying the ML model the Classification (dependant variable) is predicted.

**Table 1. Engineered table for the ML algorithms**

Intersection	Fatalities	Serious Crashes	Moderate Crashes	No of Crashes	Harsh Braking	Rapid Acc	Harsh Cornering	Speed at NCI boarder	Speed at NCI mid	Speed at NCI	No of Trips	Classification
1	0	4	1	7	51	21	62	15	9	5	256	HRI

**Results**

The initial study identified several intersections not previously identified as high risk through crash based analysis and modelling. The results were validated through field assessment and expert reviews through the NSW Centre for Road Safety. It is now confirmed that a crash risk analysis based on telematics data (drivers’ behaviour and response to road condition; no additional behaviours were considered ) using machine learning algorithms is a reliable way of analysing road

network for safety concerns and can be used as a supplementary method where data is available. With the increasing trend in telematics devices adoption by car manufacturers and insurance companies as well as incoming autonomous driving vehicles, this type of analysis will be more and more feasible and useful for reducing trauma on roads through making roads safer.

## **Bad habits while racing to the starting line: Obstacles to the development of young Learner's safe driving practices**

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\*This research by the first author was conducted while affiliated with the University of the Sunshine Coast (USC)

### **Abstract**

Graduated driver licensing (GDL) mandates extended supervised driving hours, providing opportunity to enhance young drivers' safe driving skills (Watson-Brown, 2020). Professional instructors provide a small proportion of on-road training compared to parents or lay supervisors; however, it is expected that they are equipped to teach the more safety-critical skills needed to reduce the high crash risk of newly independent novice drivers (Watson-Brown, 2020). This study aimed to explore the perspectives and experiences of instructors to understand the obstacles that inhibit the development of young drivers' safe driving practices as they traverse GDL. Thirteen southeast Queensland instructors were interviewed. A key finding was that instructors deal with an array of inappropriate ideation and behaviours that impacts the limited timeframe they have to focus on higher-order learnings that maximise safety and rule compliance. Learners' on-road training, as a critical element of GDL, could be improved with the integration of professional instruction and lay/parent supervision (Mayhew et al., 2017).

### **Background**

GDL in Queensland mandates a minimum of 100 hours of supervised driving practice for Learner drivers to be recorded in a logbook. This extended practice is opportune to develop and enhance young drivers' safe driving practices given their over-representation in road crash fatalities and serious injuries when they graduate to independent driving. In Australia, studies have found professional instructors provide approximately 10% of Learners' supervised practice with parents providing the greater part (Scott-Parker et al., 2011; Watson-Brown et al., 2019). A reliance on parents as key providers of supervision predisposes the system to obstacles in Learners developing safe driving practices (e.g., Goodwin et al., 2014). Research (e.g., Naz & Scott-Parker, 2017) has focused on the perceptions and experiences of parents and Learners with limited attention to instructors. Instructors are important to improving the safe driving practices of young drivers and optimising the current nature of on-road Learner training. It is crucial to understand the obstacles with which instructors are confronted to maximise the principles of GDL that aim to reduce the crash risk of young drivers. The objective of this study was to explore such obstacles as perceived and experienced by instructors.

### **Method**

In-depth qualitative interviews (semi-structured) were conducted with 13 (8 male) southeast Queensland professional driving instructors regarding their perceptions and experiences of

providing on-road driver training; including pre-certification training and interactions with Learners and their parents/guardians. On average, interviews lasted approximately 45 minutes. Interviews were conducted as part of a larger study that investigated the current nature of on-road professional Learner driver training. Instructors were invited to participate in the larger project through the Department of Transport and Main Roads, the Australian Driver Trainers Association, and Queensland's two largest driving schools. All instructors that were involved in the larger study were invited to participate in an interview. Therefore, the number of instructors was predetermined, however, data saturation was reached after seven interviews. Inductive thematic analysis was employed according to Clarke et al's (2015) recommendations. Four researchers, including the first author, conducted the initial analysis with the second and third authors assisted in finalising the themes.

## Results

Participant instructors reported multiple obstacles. Issues principally concerned the licensing system, parents, and Learners themselves. Instructors reported some Learners' level of driving skill was not representative of logbook hours recorded. This is potentially related to instructors noting some parents do not engage in the learning process, being too busy or lacking understanding of the purpose of extended driving practice introduced under GDL. Furthermore, instructors commented on the pressure to teach Learners the skills needed to pass the practical driving test without regard for developing safe driving practices. Consistent with this theme, instructors observe some Learners exhibit disregard for personal safety and the safety of other road users. Instructors found minimal exposure to road systems and/or driving prior to Learner licensure led to difficulties in teaching those Learners basic driving skills. Alternatively, experienced Learners with limited professional training were reported to develop negative driving habits through observation of parents' driving and/or from a lack of attention from parents during supervised driving. Additionally, instructors stated concerns regarding the need for advanced instruction skills to be able to teach the diversity of Learners encountered in lessons.

## Conclusions

These findings suggest the principles of GDL that aim to improve young drivers' safety may not translate to effective supervision, nor to those directly impacted by this system: Learners, lay supervisors, and professional instructors. Recommendations to improve GDL by better integrating parent supervision and professional on-road training are suggested. Increased parental awareness regarding the principles of GDL has potential for a flow-on benefit enhancing the safety outcomes that professional instruction could provide rather than focusing on reversing Learners' bad habits.

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## Case-By-Case Analysis of Current Fatality Trends to Estimate Future Residual Trauma in NSW

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### Abstract

Transport for NSW is developing a roadmap for setting future road safety targets to move toward zero trauma by 2056, based on methodologies developed and applied in Sweden. Case-by-case analysis of all NSW fatalities in 2018 was conducted to forecast future trauma and safety performance, using detailed crash information as well as additional information on current and planned system improvements. Analysis shows that although the current pipeline of safety interventions in NSW will bring significant benefits they will not be enough to achieve zero fatalities in 2056 and will deliver greater benefits for vehicle occupants than for vulnerable road users. While new and innovative solutions are needed to address future residual trauma, the analysis also shows that many lives can be saved in the interim with earlier implementation of already known solutions, and by adjusting policy and delivery settings of current infrastructure and vehicle solutions to be more effective.

### Background

Future Transport 2056, the long-term transport planning strategy for NSW, has set an aspirational target of zero trauma on the transport network by 2056. The Road Safety Plan 2021 commits NSW to setting new road safety targets every 10 years to move toward zero trauma.

To develop a roadmap for setting future road safety trauma and performance targets, Transport for NSW is delivering a project that applies the same methodologies used in Sweden to develop their safety target management system. A key component of the project is a detailed case-by-case analysis of NSW fatalities in 2018 to help forecast future trauma and safety performance.

### Methods

The case-by-case analysis methodology has four steps:

1. Detailed crash data was collated for all 2018 fatal crashes on NSW roads (n=347) and combined with detailed vehicle data, road asset data and pipeline project information from a variety of sources.
2. Agreement on future intervention and associated business rules around implementation time, target crash pools and treatment effectiveness.
3. Application of interventions and business rules to each fatality was assessed according to the business rules to decide whether it is likely be prevented or not in a specific year.
4. Analysis of fatalities not prevented in the future were obtained for different points in time from 2020 onwards and ultimately for 2056. The residual at different points in time, but especially in 2056, was further analysed to understand the characteristics of these fatalities.

### Results

Findings show that around 56% of fatalities that occurred in 2018 are expected to be prevented by 2056 through interventions planned to be implemented in a business as usual scenario in NSW. This assumes everything else remains unchanged and does not take into account external and general

factors. Although the current pipeline of safety interventions in NSW will bring significant benefits, it will not be enough to achieve zero fatalities by 2056.

By 2056 vehicle occupant fatalities are expected reduce by 64% while vulnerable road user fatalities only 42%. It is clear that current and planned efforts are focusing more on vehicle occupants than on vulnerable road users.

Results suggest that road safety problem areas today, despite significant improvements on previous decades, will be similar in the future (e.g. run-off road crashes on high speed undivided country roads). While innovative solutions are needed, the analysis also shows that many lives can be saved in the interim with earlier implementation of already known solutions: through accelerated uptake of vehicle safety technologies, for example. Much could also be gained in the next decade by more widespread and systematic implementation of known infrastructure safety improvements.

There are also many residual fatalities for which there is a relevant intervention but that would not be effective given current limitations of their effectiveness under specific crash circumstances. This shows the huge potential for adjusting policy and delivery settings for current infrastructure and vehicle technology to be more effective.

# Uncovering driver distraction and inattention in fatal and injury crashes

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## Abstract

Driver distraction and inattention is an increasingly challenging issue for road safety worldwide. This study investigated the contribution of driver distraction and inattention within 186 fatal and injury crashes using recent in-depth road crash investigation data from South Australia, investigated 2014-2018. Using an adapted taxonomy of inattention, five subtypes of driver inattention were defined: misprioritised attention, neglected attention, cursory attention, diverted attention (distraction) and unspecified inattention. Of the 160 crashes for which there was sufficient information, 31% showed evidence of driver inattention contributing to the crash with the most common subtype of inattention being distraction (14% of all crashes). The distraction-related crashes included a variety of different distractions with those located in-vehicle the most prevalent followed by internal thoughts. Distraction from phone use was identified in 2.5% of all crashes (18% of distraction crashes). The wider context in which inattention-related crashes occurred was also examined to assist in developing system-based solutions.

## Background (500 word limit)

Research has demonstrated that distraction and inattention can lead to diminished driving performance (e.g. Klauer et al., 2014) but there is limited evidence regarding their role in crashes. Investigating the role of distraction within crashes, and the context within which it occurs, is challenging as it is often difficult to obtain accurate information about circumstances preceding a crash. The in-depth analysis of crashes, that includes participant interviews, is likely to elicit more information about pre-crash circumstances and motivations due to the assurance of confidentiality, lack of legal consequences and ability of the interviewer to prompt the participant. Importantly, it also provides a unique approach to investigating underlying behavioural mechanisms behind inattention-related crashes (e.g. cognitive distraction) that might not be revealed using other methods. This study investigated the contribution of driver distraction and inattention within a sample of fatal and injury crashes using recent in-depth road crash investigation data. The wider context in which inattention-related crashes occurred was also examined to assist in developing system-based solutions.

## Method

The sample included in-depth crash data from 186 fatal and injury crashes in South Australia investigated from 2014-2018. Crash case notes were reviewed to determine if there was evidence that attentional failures contributed to the crash. Using an adapted taxonomy of inattention (Regan et al., 2011), five subtypes of driver inattention were defined: misprioritised attention, neglected attention, cursory attention, diverted attention (distraction) and unspecified inattention. The characteristics of inattention crashes were also compared with those for non-inattention-related crashes.

## Results

Of the 160 crashes for which there was sufficient information, 31.3% showed evidence of driver inattention contributing to the crash. A summary of the prevalence of inattention and distraction in crashes by subtype is presented in Table 1. The most common subtypes of inattention were distraction (13.8% of all crashes) and driver misprioritised attention (8.1%). The distraction-related crashes included a variety of different distractions with those located in-vehicle the most prevalent (e.g. phone

use, passenger interaction, searching for objects), followed by internal thoughts (e.g. emotional stress) and external behaviours (e.g. other road users). Distraction from phone use was identified in 2.5% of all crashes (18% of distraction crashes).

**Table 1: Prevalence of inattention and distraction in crashes by subtype**

Inattention subtype	Number of crashes (n=50)	Percentage of inattention crashes (n=50)	Percentage of crashes coded within taxonomy (N=160)
<b>Driver misprioritised attention (DMA)</b>	13	26.0%	8.1%
<b>Driver neglected attention (DNA)</b>	3	6.0%	1.9%
<b>Driver cursory attention (DCA)</b>	6	12.0%	3.8%
<b>Unspecified inattention (U)</b>	6	12.0%	3.8%
<b>Driver diverted attention (DDA - Distraction)</b>	22	44.0%	13.8%
<b>Internal</b>	7	(14.0%)	(4.4%)
<b>Task related thoughts</b>	(3)		
<b>Emotional/stressed</b>	(3)		
<b>Task unrelated thoughts</b>	(1)		
<b>In-vehicle <sup>a</sup></b>	12	(24.0%)	(7.5%)
<b>Using mobile phone</b>	(4)		
<b>Passenger interaction</b>	(3)		
<b>Adjusting/searching for object</b>	(3)		
<b>Looking down</b>	(1)		
<b>Animals in vehicle</b>	(1)		
<b>Music (headphones)</b>	(1)		
<b>External</b>	3	(6.0%)	(1.9%)
<b>Other road user behaviour</b>	(3)		

<sup>a</sup> One crash had two in-vehicle distractions; subtypes of in-vehicle distractions do not sum to 12.

In comparison to non-inattention crashes, inattention crashes were statistically significantly more prevalent in metropolitan areas (78%), occurred more frequently at intersections (60%) and on roads with a speed limit of 60km/h or lower (74%). Analysis of crash types indicated that inattention crashes were most commonly right turn/angle crashes (44%) and rear end crashes (16%).

## Conclusions

This study established that almost a third of fatal and injury crashes involved driver inattention and distraction and many of these crashes could have been prevented. System-wide solutions that could mitigate or prevent inattention and distraction crashes include intervening vehicle safety technologies, infrastructure solutions to provide a forgiving road environment, blocking capabilities within technologies to prevent communications while driving and interventions communicating the risks associated with inattention. Of significance, this study also demonstrated the importance of in-depth data for understanding the contribution of distraction and inattention in crash causation.

## Acknowledgments

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acknowledges the members of the CASR crash investigation team for their work during the data collection activity.

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## **Learner Log Book Run and Greys Driving Skill Enhancement Run**

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### **Abstract**

In partnership with the Goulburn Rotary Club GMC has coordinated a successful practical learner driver Log Book Run (LBR) for six years. Community consultation identified the need to also provide assistance to older drivers resulting in the adaptation of the LBR for local seniors. Both programs are designed to encourage confidence in driving while identifying areas for improvement. Along with a practical on-road component, the programs utilise a safe system approach providing education on safer vehicles, safer roads and roadside, safer speeds and safer road users. The delivery of the programs enables community groups to actively contribute to encouraging a road safety culture in their community and the involvement of the Council ensures the programs apply best-practice evidence based approaches. Both programs are vital in our local community, as they are reaching the most vulnerable road users, in an effort to foster a road safety culture.

### **Background**

Managing safety for 1250km road network, GMC participates in the NSW Local Government Road Safety Program (LGRSP). The program enables Council to develop and access funding for localised road safety programs to address local issues and engage with their community on road safety.

Being a regional Council located one hour drive from Canberra and two hours from Sydney, Council identified the need for local residents to gain experience in safe driving techniques for both rural roads and highway conditions.

GMC works in partnership with local stakeholders and community organisations to deliver a Log Book Run targeted at young drivers and supervisors. The program features practical on-road driving evaluated by observers, participation from local police, a display from local trucking company demonstrating heavy vehicle driver perspectives and safety talk from Council. The program conducted four times a year has been consistently well attended over six year period with positive feedback on program's surveys about enhanced exposure to safety driving techniques and increased safety knowledge for young drivers.

Discussions with senior community identified they felt 'left out' in the community's road safety and driving system and vulnerable to licensing system. Council and community groups committed to trialing a driving program based on LBR adapted for seniors. The first Grey Driving Skill Enhancement Run (GDSE) was scheduled for March 2015.

### **Method**

Both programs are supported by Council and coordinated by Council's Road Safety Officer (RSO). They are primarily promoted using organic methods of Council's community notifications and free community networks. Participating community groups, Police and local businesses donate their time, resources and delivery location (Police Driver Training Centre) to run the program. Minimal funding is provided by TfNSW (\$200) for catering. Program design and community involvement enables Council to offer the safety training free of charge to the public and this is viewed as a key component in fostering participation.

GDSE was adapted to suit local older driver needs. It uses the similar LBR on-road practical driving component with safety presentations varied featuring Police, Pharmacist, RSO and NRMA. In 2018 the GDSE program was expanded to include an additional hands on education component at Wakefield Park Raceway featuring vehicle maintenance and defensive driving techniques.

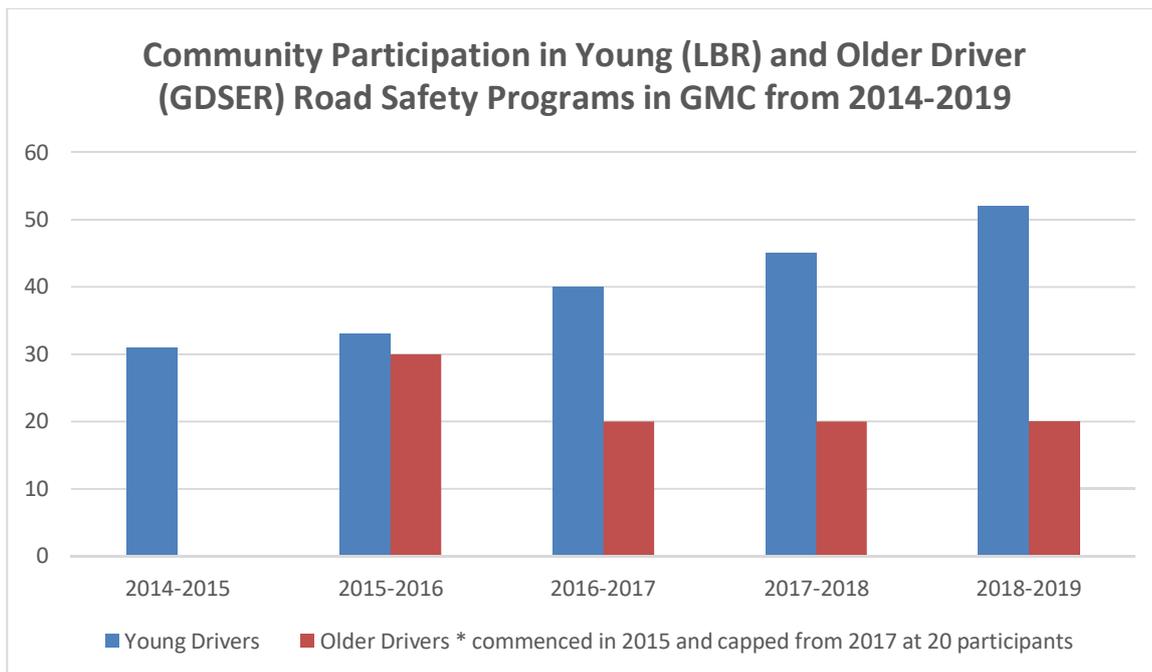
**Results:**

LBR has been successfully delivered for six years with increased community participation each subsequent year the program was conducted. The first trial of GDSER was booked to capacity with a waiting list and two programs were run to meet demand in the second year. From 2017 the program has been capped at 20 participants and remains fully booked by community members in each subsequent year it has been conducted.

Participant’s survey feedback indicates overwhelming satisfaction with the programs:

*Thanks for organising, we now have a better understanding of safe driving*

**Graph 1. Community Participation in Road Safety Programs from 2014-2019**



**Conclusion:**

GMS is utilizing road safety programs for young and older drivers to foster community contribution in building a culture of road safety for their community. The program's success is reflected by participant involvement, stakeholder and community ongoing support, media coverage and ongoing Government commitment and funding.

# Safety, design and law: a new interdisciplinary approach to bicycle rider road safety

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## Abstract

A novel problem-solving approach is demonstrated using an interaction at an intersection between a driver (turning left) and a cyclist (continuing straight). According to the road rules (RR141(2)), the bicycle rider must not to ride past on the left of a turning vehicle. However road rules and the built environment were not designed in harmony. The research hypothesis was that a new approach combining safety science, law and design were needed to approach this complex problem. The novel approach is for safety, law and design to simultaneously apply three main methods in a context of discussion. Two-dimensional drawing, three-dimensional modelling, and road rule annotation are used to represent the scenario, generate possible solutions, review, and iterate. The methods were accessible and effective for professionals from several domains.

## Background

Safety of bicycle riders at intersections brings together road space design, road rules, and safety science. In particular, the road space and the road rules are two manifestations of controls and guidance. Problem definition research in the left turns space has reported that legal considerations are made externally to road engineering, if at all. In order to develop solutions to the problem of left turn conflicts, it was hypothesised by the research team that a design approach (Lawson, 2006) could provide the means to bring these fields together.

## Method

The overarching method is the implementation of convivial (for example see Illich (1973) and Sanders and Stappers (2016)) design techniques to bring together safety science, legal investigation of road rules, and road space design. Three specific design techniques were used.

Two-dimensional drawing was tested within the research team, and external stakeholders. Three-dimensional scale modelling using LEGO® elements facilitated discussions where the two-dimensional methods were left wanting. The third technique brought road rule considerations to the foreground by encouraging road rule annotation on two-dimensional drawings.

The three techniques were applied into a research project on bicycle rider safety at left turns. They were applied throughout the project and in a stakeholder workshop with representatives from state and local governments.

## Results

Techniques of tracing and use of templates were important in overcoming any initial reluctance to draw, as the performative aspects of drawing can be a deterrent to some people. After some comfort is achieved with drawing, research reported it becoming part of the “language” of the research.

Three-dimensional modelling assisted in demonstrating spatial-temporal problems, such as sightlines between drivers of different vehicles in queues and turning. This three-dimensional modelling extended into role-playing to provide an effective means of communication for movements which sit at the core of road safety research. Although the models are not scale-accurate,

they demonstrate situations with fidelity that internal and external stakeholders all commented favourably on; an example is shown in Figure 1.



**Figure 1. Three-dimensional LEGO® model of left turn scenario used to develop safety interventions.**

When road rules are drawn, specific applications and shortcomings become more apparent, in a similar way to observing the application of road rules in naturalistic settings.

Using design to combine three fields is observed to provide a setting in which safety science, road design, and the law can co-exist and thrive. This ensures that one field does not dominate the discussion, nor was the offer from any of the fields diminished. The method has since been used in a live research and development setting with the Victorian Department of Transport to facilitate an interdisciplinary approach to complex problems of road safety. Both settings have generated interventions for road safety, combining physical and regulatory injury prevention countermeasures in concert.

## Conclusions

The complexity of the road environment, variety of users and vehicles means that a broader range of disciplines must be utilised to find new and innovative solutions. This research shows that design techniques can be used as a means to carefully and effectively unite disciplines which to date have worked largely in isolation.

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## Assessing the Ecological Validity of Button-Press Hazard Perception Tests

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### Abstract

Hazard perception tests (HPTs) assess a driver's ability to recognise potential dangers on the road and respond appropriately. HPTs have been incorporated into numerous licensing schemes typically requiring drivers to respond to videos on a computer via a button-press. However, given drivers in reality do not respond to hazards with button-presses, the present study aimed to investigate the validity of using button-presses as a way to assess real-world hazard response behaviour. The between-subjects study, compared participant performance on a button-press HPT to accelerator and brake pedal responses to the same HPT in a driving simulator. Results revealed that response times between the button-press group and pedal-press group were significantly different in more than half the clips assessed, with the pedal-press group responding consistently faster than the button-press group, to the same hazards. The findings question the ecological validity of using button-presses to capture and translate real-world hazard response skills.

### Background

Given the importance of hazard perception to driver safety, many studies have investigated the validity of various HPT methodologies, particularly the button-press HPT methods adopted by current licensing schemes (Moran, Bennett & Prabhakaran, 2019). However, although a number of studies have produced findings that support the validity of button-press HPTs (Borowsky, Shinar, & Oron-Gilad, 2010; Boufous et al., 2011; Horswill et al., 2015; Ivers et al., 2006; Scialfa et al., 2011; Wetton et al., 2011), other studies have raised questions about the validity of such a design (Chapman & Underwood, 1998; Sagberg & Bjørnskau, 2006). These inconsistent findings cast doubt on the validity of the button-press HPT and raise the need to investigate a HPT methodology that can accurately assess hazard perception skills.

The primary research aim of the study was to assess the ecological validity of the button-press HPT by examining whether button-press responses towards hazards are comparable to expected hazard response behaviours using the accelerator and brake pedals of a vehicle. Under the assumption that the current button-press HPT is a valid measure of hazard perception ability, it was hypothesised that button-press responses times and pedal-press responses times will be comparable.

### Method

A between-subjects design was employed with 32 participants (59% female) allocated to one of two groups: button-press group (presented through a computer monitor, responding via a keyboard) or pedal-press group (projected through a driving simulator, responding through the simulator pedals). Participants were required to respond to the same 26 HPT video clips. Two dependent variables were used to measure hazard perception: the time participants *anticipated* a potential hazard (e.g. Pressed "A" on a keyboard OR eased off the accelerator) and the time they *acted* in response to a hazard (e.g. Pressed "L" on a keyboard or apply the brake).

### Results

Results revealed that *anticipate* response times between the button-press group and pedal-press group were significantly different for 54% of clips analysed and *act* response times were significantly different for 65% of the clips analysed. Additionally, the study found a consistent direction to this significance, with the *anticipate* and *act* response times of the pedal-press group always quicker than the responses of the button-press group (for the clips which had significant differences in response times).

## Conclusions

The results of the study cast doubt on the ecological validity of the button-press method used by current HPTs. Given the widespread use of the button-press HPT format in current licensing schemes, it is of critical importance that these HPTs are able to validly assess the hazard perception abilities of drivers. The implications and limitations of this research will be explored to determine how HPT can be improved to ultimately enhance safety outcomes.

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## **Evaluation of a warning system to reduce the risk of casualty crashes at rural junctions in South Australia**

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Centre for Automotive Safety Research (CASR)

### **Abstract**

Rural Junction Activated Warning Systems (RJAWS) temporarily reduce the speed limit along the major legs of three-leg junctions when another vehicle is approaching from the minor road or turning right from the far-side leg into the minor leg. This study evaluated the RJAWS effectiveness and its potential to reduce the risk of casualties based on a trial at four rural intersections in South Australia. When the reduced speed limit signs are activated, the average travel speed along the major road is reduced between 11.3 km/h and 22.1 km/h, with a consequent reduction in the average relative casualty risk between 43% and 58%. Despite a relatively low compliance to the reduced speed limit, the RJAWS proved effective in reducing risky behaviour. When the sign was activated, the majority of drivers travelled through the intersection at speeds below the default speed limit. Extending the RJAWS program to additional intersections is strongly suggested.

### **Background**

Rural Junction Activated Warning Systems (RJAWS) temporarily reduce the speed limit along the major legs of a three-leg junction when another vehicle is detected on the minor road or turning right from the far-side leg into the minor leg. Previous studies indicated promising results for using RJAWS to reduce the travel speed along the major approaches (Mackie et al., 2014; Meuleners et al, 2018). A trial of RJAWS was conducted at four three-leg rural intersections in South Australia (SA) with default and reduced speed limits of 80 km/h and 50 km/h, respectively for three sites and default and reduced speed limits of 100 km/h and 70 km/h, respectively, at a fourth location.

### **Method**

This research aimed to assess whether the RJAWS can reduce the risk of fatal and serious injuries under conditions that may present the opportunity for an adjacent-direction collision with another vehicle.

Travel speeds along both major legs of four trialled intersections were measured before and after the installation of the RJAWS. The speed of free-flow events along the two major approaches to the intersection were then analysed for the after period (with either activated or non-activated reduced speed limit signs) as well as for the before period. Finally, the potential change in the risk of casualty crashes that is expected from the adoption of RJAWS was assessed considering a known relationship between relative casualty risk and travel speed in rural SA (Kloeden et al., 2001).

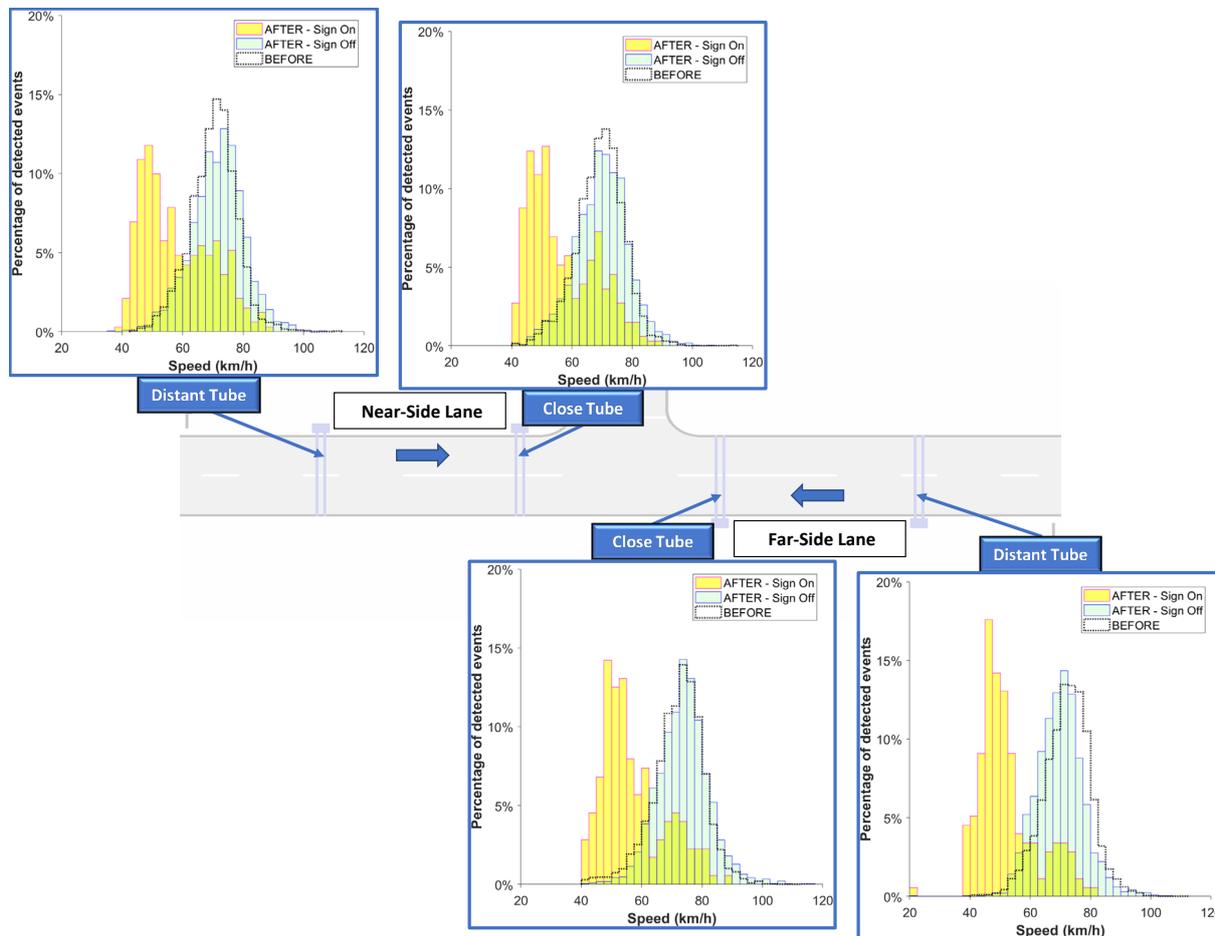
Due to issues related to the data collection, the analysis had to be limited to a period of 10 to 12 days for both the before and after periods. Also, no control could be used in the analysis; nonetheless, reasonable confidence that no external events had any influence was obtained by comparing speed data between the before period and the after period with speed signs not activated.

### **Results**

The proportion of vehicles travelling at or below the reduced speed limit in proximity to the intersection when the variable speed limit sign was activated varied between 22.6% and 65.3% across the trial intersections. Despite a relatively low compliance to the reduced speed limit, it was found

that the majority of drivers travelled through the intersection at a speed below the default speed limit when the RJAWS sign was activated.

An example of the before and after speed distributions at one trial location is shown in Figure 1. The average travel speed close to the intersection with an activated RJAWS sign is reduced by a value between 11.3 km/h and 22.1 km/h compared to with a non-activated sign. Consequently, the average relative risk of a casualty crash is potentially reduced by a value between 42% and 57% when the RJAWS sign is activated, as shown in Table 1.



**Figure 1. Example of speed distributions at distant and close locations along the approach segment of each direction of travel – Cudlee Creek (Default/Reduced Speed Limit: 80/50 km/h).**

**Table 1. Average relative risks of being involved in a casualty crash for before and after period and corresponding odds ratios**

Trial intersection	Baseline Speed <sup>(1)</sup> (km/h)	Average Relative Risk <sup>(2)</sup> (%)			Odds of Average Relative Risks	
		Before	After (Sign Off)	After (Sign On)	Rel. Risk <sub>(Before)</sub>	Rel. Risk <sub>After(Sign On)</sub>
					Rel. Risk <sub>After(Sign Off)</sub>	Rel. Risk <sub>After(Sign Off)</sub>
Cudlee Creek Rd/Fox Creek Rd	80	70.4	76.6	38.5	0.92	0.50
Bull Creek Rd/Paris Creek Rd	80	61.3	62.3	35.6	0.98	0.57
McLaren Flat Rd/Bakers Gully Rd	80	80.7	72.2	40.3	1.12	0.56
Horrocks Hwy/Stradbroke Rd	100	88.1	72	30.6	1.22	0.42
<b>Average Odds for all trial sites</b>					<b>1.06</b>	<b>0.54</b>

<sup>(1)</sup> Default speed limit at each site used as baseline speed

<sup>(2)</sup> Relative to the risk at the baseline speed

## Conclusions

The RJAWS can effectively reduce the risk of casualty crashes by decreasing the speed of vehicles travelling along the major intersection approaches when there is a potential for an adjacent collision with another vehicle. It is suggested to expand the installation of RJAWS to a larger number of intersections. This will also provide the opportunity to collect speed data in a more precise and detailed manner to carry over a control-case study in the future.

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## A methodological approach to reducing connected vehicle data

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### Abstract

The second stage of Transport for NSW's Cooperative Intelligent Transport Initiative (CITI) collected high volumes of raw in-vehicle data from 55 privately-owned light vehicles fitted with trial equipment over a ten-month period. Data were collected from two different devices fitted to participants' vehicles. The cooperative intelligent transport system (CITS) recorded data transmitted and received at 10 Hz (up to 10 datapoints per second) while a telematics device recorded data at 40 Hz (up to 40 datapoints per second). It was essential to translate the hundreds of millions of data records into a more concise format to address research questions. This presentation addresses the intricacy required to reduce the data to engineer analytical datasets, reducing noise in the data and producing a range of summary datasets, maintaining quality outcomes to allow the investigation of road safety benefits and limitations of the CITS alerts.

### Introduction

Investigating research questions related to the safety benefits and limitations of using connected vehicle data requires raw datasets to be reduced to provide core information. The collection, storage and transformation of largescale multi-source big data requires effective and reliable handling and processing techniques to validate and document reproducible results.

### Methods

The two devices were fitted in each vehicle, a CITS (recording received and transmitted basic safety messages (BSMs)) and a telematics device (recording accelerometer and geolocation data). Traffic lights at three signalised junctions were also fitted with CITS. The study consisted of three possible warnings issued to drivers of the equipped vehicles: red light (RLW), intersection collision (ICW), and harsh braking ahead warnings. These three possible warnings were called HMI (human-machine interface) alerts for the purpose of this study. The following datasets were processed to engineer the analytical datasets:

- CITS BSMs transmitted between vehicles
- CITS BSMs received from traffic lights fitted with CITS equipment
- Alerts recorded by the in-vehicle CITS devices (RLW and ICW)
- Data from telematics devices including timestamped location and tri-axial acceleration data

The following processing methods were applied to validate and reduce the data:

- Data validation, checking the accuracy and reliability. Each row that met an extensive list of validation checks were given a flag that can be filtered if required as part of the study.
- Create unique trips that were defined by the set of rules defined by the research team, where one Vehicle Identification Number (GID) may not have a gap in data greater than 2 seconds.

- Data reduction to 10 seconds either side of a CITS alert while maintaining the original sampling rate of the data. Using spatial data preparation and transformations to assist in this process.
- Data aggregation to analytical datasets by combining all data into events containing one or multiple alerts. CITS and telematics data were linked by timestamp and Vehicle Identification Number (GID).

## Results and Conclusion

Concentrating on a reduced number of data points that are around the alerts is a fresh approach to minimise the burden on the research team and allows them to analyse the 2,663 RLW and 160 ICW events.

Table 1 and Table 2 demonstrates the number of data points before and after the data engineering process.

**Table 1. Size of raw datasets, number of data points**

BSM Tx	BSM Rx	Telematics Records	ICW Alerts	RLW Alerts
506,631,605	8,822,313	1,097,574,320	215	2,917

- BSM Tx: transmitted dedicated short-range communication (DSRC) messages, including BSM messages from the vehicle, which contain details about the location of the vehicle, speed, heading, acceleration, deceleration, etc.
- BSM Rx: received DSRC messages, including BSM messages from various connected vehicles passing by.
- HMI Alerts: Human-Machine Interface (HMI) alerts

**Table 2. Size of engineered analytical datasets, number of data points**

CITS RLW Events	CITS ICW Events
2,663	160

- CITS RLW Events: CITS records matched to the RLW events
- CITS ICW Events: CITS records matched to the ICW events

## Evaluation of a prototype driver distraction human-machine interface warning system

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### Abstract

Recent advances in vehicle technology permit the real-time monitoring of driver state to reduce fatigue and distraction related crashes, particularly within the heavy vehicle industry. Relatively little published research has evaluated the human machine interface (HMI) design for these systems. However, the efficacy of in-vehicle technology depends in part on the usability and acceptability among drivers of the system's interface. The HMI of a prototype multi-modal warning system developed by the authors for driver distraction was evaluated in a truck simulator with eight car and six truck drivers using the System Acceptability Scale, comprehension and open questions. The results showed that all participants perceived the system as acceptable and useful, and that the warning modalities (visual, auditory and tactile) were largely understood correctly and perceived to be effective. This study identified no major design flaws with the recently developed HMI, but on-road evaluations are recommended to validate these findings.

### Background

Driver fatigue and distraction are significant contributing factors to crashes including those involving heavy vehicles (Fitzharris et al., 2017). Recent advances in vehicle technology permit the real-time monitoring of driver state to address these issues (Lenné et al., 2018), however, relatively little published research has evaluated the interface design for these systems. This represents an important gap since the efficacy of any in-vehicle technology depends in part on the usability and acceptability among drivers of the human-machine interface (HMI) (e.g., Regan, Stevens and Horberry, 2014). This paper evaluates the HMI of a prototype multi-modal warning system for driver distraction in car and truck drivers. The warning system was developed by the authors as part of a larger project using human centred design principles.

### Method

#### *Participants*

Six truck drivers and eight car drivers (mean age 38.4, three female) with an average of 19 years' driving experience were recruited from the MUARC Participant Database.

#### *Driver distraction HMI prototype*

The two-level system comprised a cautionary warning followed 1.5 or four seconds later by an urgent warning that escalated in intensity if distraction persisted after the initial alert. The system was multimodal with simultaneously presented auditory alerts at both levels comprising 'beep' tones, a spoken warning and tactile vibration through the seat and a visual alert at the urgent warning stage.

The HMI evaluation instruments and interface conditions used in the study are presented in Table 1.

**Table 1. HMI evaluation instruments and interface conditions**

<b>Instrument</b>	<b>Description</b>
System Acceptance scale (SAS) (Van der Laan, Heino & De Waard, 1997)	To assess system acceptance on two dimensions, 'Usefulness' and 'Affective Satisfying' as measured on 5-point likert scales from -2 to 2 (where higher scores indicate positive ratings).
Comprehension questions	To determine whether participants noticed and understood the warnings. Comprehension was measured from 0-2 where 0 represents no or incorrect understanding, 1 represents partial understanding and 2 represents full understanding.
Post-drive open questions, including of perceived effectiveness	To obtain additional views about the HMI including relative ratings of the perceived effectiveness of each interface condition and the various modalities (visual, tactile, auditory) for alerting the driver. A four-point scale was used with: 4 very effective, 3 effective, 2 ineffective and 1 very ineffective.
<b>Interface condition</b>	<b>Description</b>
No warnings	Control – presented as the third condition to prevent drivers always expecting a warning after being distracted.
Two-stage (cautionary – urgent) warning: short	<p>The <b>cautionary</b> warning comprised an auditory alerting tone then a simple spoken message in a local female voice ('pay attention') which was presented at the same time as a tactile warning (intermittent pulsing of driver's seat).</p> <p>The <b>urgent</b> warning comprised a louder, more urgent alerting tone then a simple spoken message in a local female voice ('pay attention now!') which was presented at the same time as: a visual warning: eye graphic as a Head Up Display on the windscreen and a louder more urgent tactile warning (intermittent pulsing of the driver's seat).</p> <p>Both stages were presented with a 1.5 second gap between the cautionary and urgent warning.</p>
Two-stage (cautionary – urgent) warning: long	As above but with a four second gap between the cautionary and urgent warning.
Cautionary warning	Only the cautionary warning presented.
Urgent warning	Only the urgent warning presented.

## ***Procedure***

Participants completed a 20-minute drive in MUARC's advanced truck driving simulator. Before driving they received the four interface conditions (presented in counterbalanced order) (See Table 1) and gave feedback after each one using the SAS. Approximately five minutes into the drive, participants were instructed to engage in a short text messaging distraction task which was explained to them prior to the experiment. They were then presented with one of the four conditions and asked to stop driving about 30 seconds later and provide feedback using the comprehension questions. This cycle was repeated four times (including the control) with the warnings presented in the same counterbalanced order as the pre-drive. Participants were advised pre-drive that they would receive four warnings at some stage during the drive and that they should 'respond in the way that you think is appropriate' after each warning. At the conclusion of the drive, each condition was again played in turn, and feedback was given using the SAS. Participants then completed the post drive open questions and were paid for their participation.

## **Results**

The results show that all participants perceived the interface conditions as acceptable and useful and that most participants understood the warning modalities and considered them to be effective. Participants generally gave more favourable ratings as their familiarity with the warnings increased, which suggests that understanding the system is likely an important component of user acceptance. The multimodal presentation of warnings was rated favourably as redundancy was thought to overcome problems associated with a single mode of warning not capturing the driver's attention. Participants suggested that a two second gap would be preferable to the 1.5 and four second gaps presented between the cautionary and urgent warnings. This was thought to provide optimal time for the driver to re-orient their attention back to the roadway.

## **Conclusions**

This study identified no major design flaws with the recently developed HMI but did identify small iterative improvements. On-road evaluations are recommended to further validate these findings.

## **Acknowledgements**

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## **Towards zero: safety testing of police motorcycle jackets**

Michael Timms

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### **Abstract**

By 2019, New South Wales Police Force (NSWPF) operated a motorcycle fleet of 120 road bikes. With riders increasingly exposed to all weather and road conditions, Traffic and Highway Patrol Command (THPC) commenced a search for high-visibility summer and winter motorcycle jackets that could provide improved safety and comfort.

The timing of the project coincided with the establishment by Australian and New Zealand road safety agencies of the Motorcycle Clothing Assessment Program (MotoCAP), a world-first rating system for motorcycle clothing.

THPC partnered with Deakin University to subject prospective jackets to the MotoCAP testing protocol and worked with a clothing manufacturer to build additional safety into their products.

This combination of road safety/safe systems methodology and work health safety (WHS) due diligence represents a fresh approach to the procurement of uniform for organisations that operate motorcycles, as well as the manufacturers who supply that clothing.

### **Background**

Following WHS consultation with THPC's Motorcycle Consultation Group (MCG), it was decided to improve safety and visibility by replacing existing black fabric and leather jackets with summer and winter weight jackets.

The jackets had to be safe, comfortable, and durable for use every day, including some water resistance particularly for the winter jacket. MCG requirements added high-visibility materials to negate the need for a separate reflective vest.

No uniform supply contract existed for these specifications and Australian Standards for motorcycle clothing are lacking. MCG members therefore looked for options in stores and on websites.

At this time, transport agencies in Australia and New Zealand created the MotoCAP rating system for motorcycle clothing. Options on the MotoCAP website were considered but the MCG preferred to look at existing suppliers to interstate police.

Products from an Australian law enforcement clothing manufacturer not available to the public were identified. With assistance from specialist police, they were risk assessed against confidential operational safety requirements and the Australian Standard for high visibility.

A workplace trial in a range of climatic conditions found the prospective summer and winter jackets to be suitable in terms of comfort. After performing tasks on and off the bike, riders completed a multi-point checklist.

However, in the absence of any crashes during the trial, rider safety could not be truly evaluated. Enter MotoCAP.

THPC took the position that no new motorcycle uniform should be procured unless subjected to assessment using MotoCAP protocols. Therefore, arrangements were made with Deakin University for the prospective jackets to undergo that process.

## Jacket Safety Testing

THPC contacted Transport for NSW and the Deakin University researchers who conduct the testing on behalf of MotoCAP. Only publicly available clothing is normally tested by MotoCAP, but the test protocols were made available allowing for independent testing in accordance with those protocols. The manufacturer had no objections to their jackets being tested.

On 8 October 2019, THPC were invited to attend the Motorcycle Clothing Test laboratory at Deakin University near Geelong, Victoria. Two summer and two winter prototype textile jackets were provided for assessment.

Elbow, shoulder, and back impact protectors were the same on both jackets. Whilst the elbow protectors provided good coverage, the shoulder protectors were found to be too small, and it was recommended that larger “B” size protectors be fitted.

Conversely, the Level 2 back protectors were too thick and were reported to be uncomfortable. Due to the risks associated with discomfort and the possibility riders might remove such protectors, it was decided to use smaller more appropriate protectors of similar quality. It should also be noted there is little scientific evidence that back protectors reduce spinal fractures (de Rome et al, 2011).

The jackets underwent tests including impact abrasion resistance, seam burst strength and thermal management. A video of the MotoCAP testing protocol conducted by Deakin University can be viewed at <https://www.youtube.com/watch?v=hceK6FX0JHM>.



**Figure 1.** Abrasion testing shown here on the summer jacket provided 2.52 seconds of resistance (left). Experiments that added an additional layer of fabric almost doubled that time to 4.49 seconds (right). This information was conveyed to the manufacturer.

Based previous police motorcycle crashes where riders slid on the road, THPC were particularly interested in abrasion testing. Testing found that both jackets could be improved with additional layers of fabric. (See Figure 1).

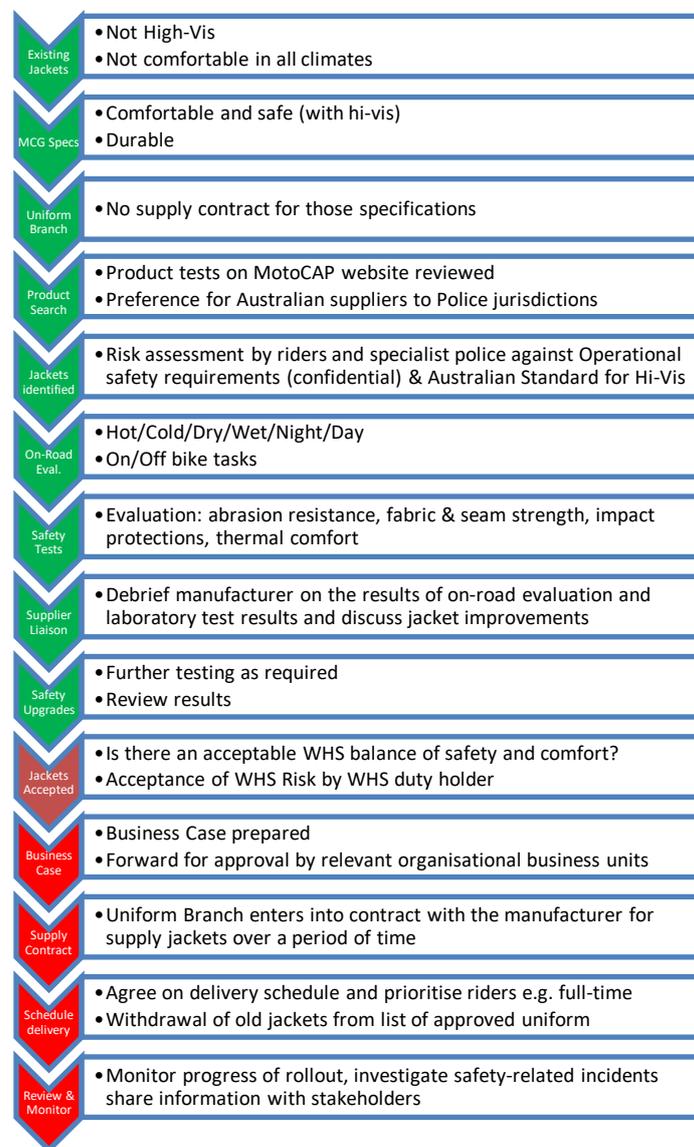
Importantly, thermal comfort for the summer jacket was considered satisfactory and riders raised no complaints regarding the water resistance of the winter jacket, noting riders are issued full wet weather gear.

## Product Improvements

The Deakin researchers provided recommendations for improving the safety and comfort of both jackets. The findings were discussed with the manufacturer who agreed to make changes to their products.

When improved products were subjected to fresh testing, the safety and breathability scores for both jackets improved to the point where a procurement business case could be made. The changes made the garments best in class when benchmarked against equivalent jackets rated by MotoCAP.

**Table 1. Process flowchart: Green denotes steps completed, orange denotes project status as of 2020, red denotes further (indicative) steps. This process could be adapted to other organisations or motorcycle safety products**



### Future Procurement

This is the new standard procedure for uniform-issue motorcycle clothing. It is reasonably practical for employers and manufacturers to work with Deakin University to achieve improved performance against the MotoCAP testing protocol and it demonstrates WHS due diligence.

### Acknowledgments

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Dr Chris Hurren, Deakin University

Mr David Beck, Chair of the MotoCAP Working Group and A/Manager Safer Vehicles, Centre for Road Safety, Transport for NSW

Leading Senior Constable Mark Trethowan, Traffic and Highway Patrol Command

Assistant Commissioner Michael Corboy APM (Retired), Traffic and Highway Patrol Command

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Motorcycle protective clothing: Protection from injury or just the weather? Accident Analysis and Prevention 43 (6), 1893-1900.

## **Analysis of rear-end and other crashes related to roadwork sites in NSW**

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### **Abstract**

Transport for NSW (TfNSW) commissioned the Australian Road Research Board (ARRB) to conduct a systematic analysis of rear-end crashes (and other crash types) in NSW to identify key reported contributing factors to reduce their frequency and impact. The review analysed 118,628 crashes recorded in the CrashLink database reported in 5-years 2013 to 2017. Data were analysed by examining count data, percentages and cross-tabulations across a number of levels of analysis by crash location and crash type. Of all reported crashes, 1.43% (1693/118628) were related to roadwork zones and 40.3% of these (682/1693) were rear-end crashes. Rear-end crashes were more likely to be related to roadwork zones compared to non-rear-end crashes. Roadwork zone crashes tended to have more severe outcomes on rural roads, with heavy vehicles as the key traffic unit. One in five rear-end roadwork zone crashes involved distraction. These findings may assist when considering implementing countermeasures to reduce the likelihood of rear-end crashes related to roadwork zones.

### **Background**

In recent years, a number of serious end-of-traffic-queue collisions have occurred at roadwork sites in NSW, with some of these resulting in fatalities and serious injuries. To identify appropriate countermeasures to prevent re-occurrence, the Safety Branch at TfNSW commissioned ARRB to conduct a systematic study into these types of incidents to consider if further traffic management controls could be applied.

A key component of this study was to compare the incident rate of rear-end and other crashes at or related to roadwork sites in NSW to rear-end crash rates at other locations in NSW over the latest 5 year reporting period available from the NSW CrashLink database (2013-2017). Using these data, we sought to analyse and compare the reported contributing factors to these crashes, including appropriate breakdowns by rural versus urban areas, roadworks and no roadworks, and crash outcome severity.

### **Methods**

Access to the CrashLink dataset for the purpose of this analysis was provided by the Centre for Road Safety, TfNSW. The datasets contain crash, traffic unit and person records for all reported crashes in NSW as summarised from information collected from NSW police and hospital records. Data from 2013 to 2017 inclusive were analysed using a data visualisation tool, Power BI, and Microsoft Excel. Four levels of analysis were undertaken to investigate reported crashes on the NSW road network by crash type and location:

- Level I. Involved all eligible crashes grouped by crash type and location.
- Level II. Involved rear-end crashes by crash location.
- Level III. Involved roadwork zone crashes by crash type.
- Level IV. Involved rear-end related to roadwork zones.

At each level of analysis, crashes were further analysed by other factors of interest, such as degree of crash, degree of casualty, key vehicle unit type, road type, day of week, time of day, road condition, and involvement of recorded human factors such as distraction, fatigue, speeding or alcohol. Data were primarily analysed by examining count data and percentages. Cross-tabulations were used to examine relationships between variables.

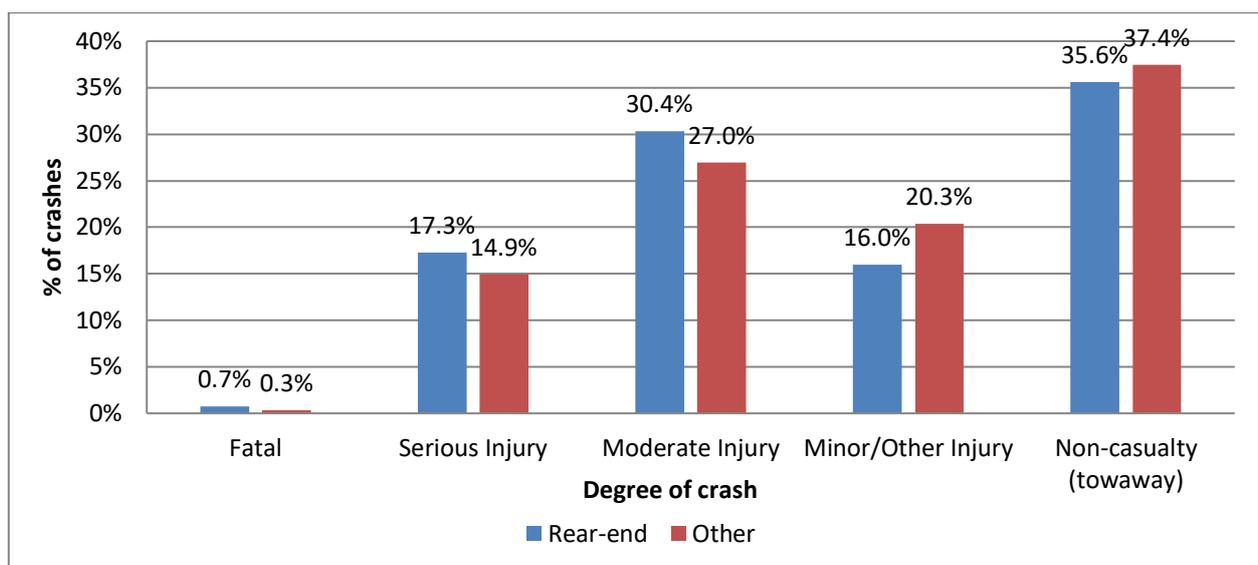
**Results and Conclusions**

Of all reported crashes, 1.43% (1693/118,628) were related to roadwork zones (Table 1). A higher percentage of these crashes (40.3%, 682/1693) were rear-end crashes compared to rear-end crashes occurring outside of roadwork zones (23.0%, 26,888/116,935). Rear-end crashes were more likely to be related to roadwork zones, and occur in urban areas, on weekdays, between 8 AM and 6 PM, and in good driving conditions. Crashes in roadwork zones were likely to result in more severe crash outcomes as measured by both degree of crash (Figure 1) and degree of casualty compared to crashes at other locations. Heavy vehicles were more likely to be a key traffic unit in rear-end crashes and roadwork zone crashes compared to other types of crashes and crashes occurring outside of roadwork zones. One in five rear-end roadwork crashes were identified as involving distraction, while the frequency of fatigue, speeding, and alcohol involvement were low.

These findings may assist when considering (1) the types of countermeasures to be implemented to reduce the likelihood of rear-end crashes related to roadwork zones based on specific types of crashes or vehicle controllers, (2) where countermeasures should be located, and (3) identification of target road users for safety campaigns.

**Table 1. Number of reported crashes occurring in NSW by crash type and location (n = 118,628 reported in the 5-years 2013-2017)**

Crash Type	Roadwork Zones	Other Roads	Total
Rear-end crash	682	26,888	27,570
Other crash type	1011	90,047	91,058
<b>Total</b>	<b>1693</b>	<b>116,935</b>	<b>118,628</b>



**Figure 1. Percentage of crashes related to NSW roadwork zones by degree of crash and crash type (n = 1693 reported in the 5-years 2013-2017)**

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## Young Novice Drivers' Speed Management: A Systematic Review

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### Abstract

Excessive speed is a persistent contributor to road trauma, with this risk exacerbated by youth and inexperience. This research aimed to systematically review literature on contributing factors to young driver travel speeds. Searches of key databases for research published between January 2009 to June 2021 yielded over 2,000 records. Of 167 full paper reviews, 46 intervention and 54 studies of individual characteristics and situational vehicle, road environment, performance and behavioural factors were included. The findings provide insights into potential fresh approaches to education on speed management when learning to drive, additional to the current stronger focus on volitional speed behaviour.

### Background

Excessive speed is a persistent, prevailing contributor to road trauma. For young drivers, this risk is exacerbated by inexperience and developmental influences. Many factors contribute to speed judgment and management, which can result in speeds too high for conditions, irrespective if over the posted speed limit (i.e., speeding). These risky speeds can be intentional or unintentional, especially for new drivers who have not yet developed an instinctual 'feel' for travel speeds or vigilance in allocating attention to the vehicle speedometer. Despite this, many road safety education and training efforts targeting youth focus on volitional speeds, particularly speeding.

The aim of this research was to conduct a systematic review of literature on factors contributing to young driver travel speeds. The overarching objective was to highlight a range of factors that result in inappropriate speeds, beyond driver intentions.

### Method

Embase, Scopus, Transportation Research Information Database and Web of Science databases were searched in May 2019 applying the following search terms: speed\* AND (young OR provisional OR probationary OR intermediate licen\* OR restricted licen\* OR graduated licen\* OR novice OR teen\* OR adolescen\* OR newly licen\*) AND driv\*. The search was restricted to commence at approximately 10 years earlier (2009). Subsequently, an updated search was performed in July 2021. Any grey literature identified by these searches was included and qualitative-only or non-English-only publications excluded during screening.

Selection criteria focused on restricting to a general young driver population: 'young' based on the United Nations' definition of youth (age 15-24 years; <https://www.un.org/development/desa/youth/what-we-do/faq.html>); 'driver' being an independently licensed driver (i.e., post-learner and not unlicensed); and 'general' relating to 'everyday' driving of standard passenger car-type vehicles (i.e., not motorcycling or heavy vehicle driving or special groups, such as youth with cognitive or physical impairments, commercial drivers or shift-workers). Selected studies had to include findings on at least one factor that contributed to young drivers' actual speed behaviour or performance (safe or unsafe) as an outcome (e.g., not speed attitudes or intentions only). Studies that only identified travel speed differences by age, gender or race/ethnicity were excluded.

## **Results**

After removing duplicates from a total of 2,882 extracted records, 2,278 records were screened with 167 full-text articles assessed for eligibility. Of these, 99 publications meet eligibility: 46 intervention studies (e.g., training programs or advanced vehicle assistance systems). The remaining studies highlight an array of factors from distraction, impairment, personality and social factors to weather, traffic and other road user environment, road and vehicle features, driver mood, alertness, visual search patterns and cognitive capacity and workload.

## **Conclusions**

This research highlights a wealth of factors that contribute to young driver travel speeds that have influences beyond whether or not they intend to speed or drive too fast, generally or at a given moment when driving. It is anticipated that the final results will have implications for fresh approaches to better educate young drivers on speed management practices during the learn-to-drive process.

# Guidelines to provide Roadside Protection for Motorcyclists

David Milling<sup>a</sup>

<sup>a</sup>Australian Road Research Board

## Abstract

Currently in Australia Guidelines are not published to assist in identifying when safety barriers should be provided to protect motorcyclists from unforgiving roadsides. This includes guidance for the installation layout and lengths of a motorcycle-friendly barrier. Some approaches for identifying when to provide treatments include consideration of Black Spots, Black Lengths or routes with high motorcycle volumes. These approaches do not always result in the highest risk locations being treated additionally, the design and installation of protection is likely to vary. A proactive, warrant based approach is required to identify when to provide roadside protection for motorcyclists. Guidelines defining a Motorcycle Protection System (MPS), identifying and prioritising where to install MPS's, and how to determine the layout and length of MPS has been developed. These guidelines will allow for MPS's to be proactively installed, contributing to providing safer roadsides for motorcyclists and reducing the crash severity of motorcycle run-off-road crashes.

## Background

Motorcycles account for 5.7% of all Australian passenger vehicle registrations and 1.2% of passenger vehicle kilometres travelled. However, motorcycle riders and pillions account for approximately 19% of all road crash deaths and an even higher proportion of serious injuries (Centre for Accident Research and Road Safety – Queensland. (2017). The Austroads reports 'Motorcycle In-depth Crash Study' (Austroads 2015) and 'Infrastructure Improvements to Reduce Motorcycle Casualties' (Austroads 2016) both identify that motorcyclists are vulnerable to fatal injuries resulting from striking roadside objects, which includes safety barriers.

Between 2008 to 2017 a total of 1,308 motorcycle run-off carriageway on a curve injury crashes occurred in Queensland, 132 were fatal and 913 resulted in hospitalisation. In 85% of these crashes, the motorcyclist hit an object, resulting in run-off-road on curve hit object crashes accounting for 72% of the (1,045 crashes) fatal and hospitalisation motorcycle run-off road crashes. Eleven fatal and 191 hospitalisation crashes resulted from run-off-road on curve crashes where an object was not hit.

Proactive warrant based guidelines were developed to identify and prioritise where to install MPS's. Guidelines were also developed to determine the required layout and length of MPS's. These have been developed to proactively reduce the crash severity of motorcycle run-off-road crashes.

## Method

A crash analysis was undertaken to examine the relationship between road infrastructure, posted speeds and motorcycle off-carriageway casualty crashes to identify pre-crash contributing factors. The key pre-crash contributing factors (infrastructure and rider behaviour) on curve crashes were identified and categorised by the influencing road attribute.

The findings from the crash analysis and pre-crash contributing factors were used to develop five high-level warrants which when met would identify the need to provide a MPS. The high-level warrants were applied to the network to determine the number of sites that would be identified for MPS to be provided. The percentage of total number identified sites which were collocated with a site that had a historical motorcycle run-off-road crashes was used as a measure of suitability for each warrant. The warrant options included proactive and quantitative risk criteria using the AusRAP

Motorcycle run-off-road Star Rating Score (SRS). The SRS was also used to develop a network intervention level risk score to explore the number of sites that may result if only the highest risk sites on the Queensland (QLD) network were treated with a MPS, providing a platform for a mass action plan analysis.

Identification of the limitations of a w-beam and motorcycle rub rail, end treatments and delineators was undertaken to identify the most suitable safety barrier components and layout that should be used to provide a MPS. A review of the current installation guidance, the layout of current installations and the resulting hazards for an errant motorcyclist was undertaken. The possible motorcycle riding paths and exit angles on horizontal curves were considered to estimate where a motorcyclist (sliding on the road surface or still upright) may depart during or exiting a manoeuvre on a curve.

## Results

The most effective high-level warrant option was applied across the QLD state-controlled network, demonstrating that 52% of historical motorcycle run-off-road on curve crash sites would be identified as requiring a MPS. This is a validated finding, given the known variance in the statewide data used to undertake the analysis. This warrant considers all posted speed limits and sites where the SRS is categorised as high. The four alternate high-level options identified that between 23% to 41% of historical crash sites would have been identified to require a MPS, these options did include speed or network intervention level SRS.

The high-level warrant option was developed into a detailed warrant-based decision tree. The decision tree considered road features identified as key contributing crash factors to identify if a MPS should be provided. The warrant considerations included curve radius, superelevation, sealed width, complex geometry, operating speed differences between successive curves, sight distance, road surface texture and condition. The decision tree was applied to historical crash locations with successive horizontal geometry. The decision tree indicated that a MPS should be provided on all curves at each location, these results complemented the underlying warrants, quantitative AusRAP SRS and what would be expected from an assessment by an experienced road safety practitioner. Each assessment was undertaken using aerial mapping websites and was completed in approximately 20 minutes.

A description of what components should be included in a MPS was provided, this includes consideration of components to reduce trauma to motorcyclists that may strike a safety barrier whilst sliding on the road or if in an upright position. Guidance was provided for the start and end installation locations of the MPS and considers an errant motorcyclist departing the shoulder in the direction of travel (passenger or driver shoulder) or crossing an opposing lane (driver shoulder). The lengths to extend the MPS past the curve exit is provided, this is to place the end treatment outside of a potential errant path of a motorcyclist. The MPS layout and length guidance is based on curve radius and the offset of the MPS from the edge line (or edge of seal).

## Conclusions

The guidelines provide an evidence-based, consistent method to assess and identify the need to protect motorcyclists from the roadside during the road design (green or brownfield) process or when proactively identifying risk on an existing route.

Guidelines based on quantitative motorcycle run-off-road crash risk and the associated contributing crash factors are provided in an easy to use decision tree. The guidelines identify if a MPS should be provided and what the associated priority for installation is. The priority for providing a MPS ranges from immediate installation to the inclusion in a strategic plan.

Guidance to determine what features should be included in an MPS, and how to determine the MPS layout and length is provided. The layout and length guidance is provided to ensure errant motorcyclists are protected from roadside hazards and end treatments throughout a manoeuvre on a curve.

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## Complete Streets Victoria: The Cycling Guide

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<sup>a</sup>Department of Transport, <sup>b</sup>Arup, <sup>c</sup>Gehl

### Abstract

During 2019 and 2020 the Department of Transport with consultants Arup and Gehl are developing a design guide for cycling as transport in Victoria. *The Cycling Guide* is the first of a suite of modal-specific guides to support *Complete Streets Victoria*, an urban roads and streets design guide. This project represents a Victorian-first approach to design and planning cycling infrastructure that will empower and encourage practitioners to raise the standard of the Victorian cycling network and create safer outcomes for people who ride. The project takes a new safety-first, user-focused approach that captures whole of trip considerations. It provides strategic and technical guidance underpinned by safe systems to give practitioners confidence to implement safer more inclusive infrastructure.

### Background

In September 2019, the Department commissioned Arup and Gehl to develop the first modal specific design guide that sits within the *Complete Streets Victoria* package. Together these guides form part of the Department's *Movement and Place Framework*, assisting practitioners to develop project options and to ensure road and street design considers the safety and needs of all users in different contexts. A fundamental driver underpinning the project is the need to integrate a safe systems approach with planning and design to deliver cycling infrastructure that eliminates the likelihood, severity and consequence of accidents occurring for cyclists.

### Project purpose and description

The current set of technical design guidance for cycling infrastructure are not delivering a safe, convenient and attractive cycling network. Research undertaken by Austroads has shown that cycling participation has plateaued in Melbourne and consistently fallen in regional Victoria since 2011 (Austroads, 2019). Despite a strong understanding from transport planners and engineers of the importance of safety in encouraging cycling as an attractive transport choice, the current road network is unsafe for people who ride. In 2018, Victoria saw the lowest number of lives lost due to road trauma, however in 2019 there was a 100% increase in fatalities of people riding bikes (TAC, 2019).

*The Cycling Guide* intends to become a central source of reference for planning and project practitioners to design safer streets for people who ride. It articulates design standards for on-road separated lanes, traffic calming for cycling, off-road paths and intersections to achieve safer and more inclusive street layouts that encourage participation in cycling for transport.

The guide aims to:

- be an essential resource for designing safer streets for people who ride;
- show what success looks like for safer, lower-stress, better-connected cycling networks and infrastructure;
- take a people-first approach, providing guidance on considerations for the varying needs of cyclists taking different trips at different times of day;
- capture local and global best practice for whole-of-journey considerations, including bicycle network planning, infrastructure design, intersection design, wayfinding, parking, end-of-trip facilities and the overall user experience;

- help practitioners and decision makers make trade-offs and resolve conflicts;
- empower practitioners to overcome barriers across the project lifecycle to make an impact on the safety and attractiveness of cycling as transport
- hold us all to account.

### **Evidence base**

The project draws on current standards and guidelines nationally and internationally to reference, consolidate and identify guidance needing retention or review. The guide draws on learnings from global and local best practice design and from key stakeholders including practitioners, industry experts and advocacy groups. At critical points of the project, content is pressure tested by a Technical Reference Group and a Place Reference Group.

### **Next steps**

The final draft will be released in early May 2020. It will undergo a process of feedback, consultation and refinement.

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## What computer vision can tell us about road safety?

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### Abstract

Aims to reduce fatalities on city roads by 2030 and within Australia by 2050 have been set but current methods to evaluate and validate safety through crash data do not allow for fast development cycles, often taking years to collect statistically representative data. If these aims are to be met, new methods of safety evaluation must be utilised to decrease the evaluation and validation cycle. Computer vision (CV) has recently become a viable technology for use in this area with its ability to extract a range of road user characteristics. This research explores previous safety research using CV, the current limitations of CV systems, and the next advancements of CV that could give new, exciting tools for evaluating safety. Also presented is a CV system capable of extracting road user characteristics for road safety studies and to build upon with new CV techniques.

### Background

Surrogate measures of road safety are those which do not utilise crash, injury, or fatality data to draw conclusions. Measures often include using speeds, collision angles, vehicle counts, and near crash events. Near crash events have historically been difficult to classify due to the use of subjective human observation and high labour requirements. Advancements in computer vision over the past decade have begun automating the task of observing near misses and severe conflicts, giving researchers a new tool for improving road safety.

The method of extracting road user characteristics includes computer vision techniques such as feature tracking and object detection. From this data researchers can extract rich trajectory data including instantaneous speeds, intersection entrance/exit locations, and surrogate safety indicators (SSIs). There are a range of SSIs (Mahmud, Ferreira, Hoque and Tavassoli (2017)) however the most commonly used are post encroachment time (PET) and time to collision (TTC). These SSIs have been used in many different situations including highway driving (Jackson, Miranda-Moreno, St-Aubin and Saunier (2013)), cyclist safety (Niaki, Saunier and Miranda-Moreno (2019)), and pedestrian safety at intersections (Scholl, Elagaty, Ledezma-Navarro, Zamora and Miranda-Moreno (2019)).

### Method

A pair of cameras were installed at opposite corners of a simple 4-way intersection. Video was recorded for 8-12 hours during day light hours. These recordings were analysed using various CV techniques including object detection, localisation, tracking, and multiple camera geometry. To extract data from multiple cameras the video frames are analysed separately beginning with a detection phase that extracts all the road users in the scene along with their location. The detected objects are all then combined over the two views giving a complete list of all road users within the intersection despite occlusions and truncations (Reddy, and Narasimhan (2019)). After these locations and trajectories are extracted from the video this data can be analysed separately to extract high level information such as SSIs, entrance/exit locations, and speed throughout the intersection.

### Results

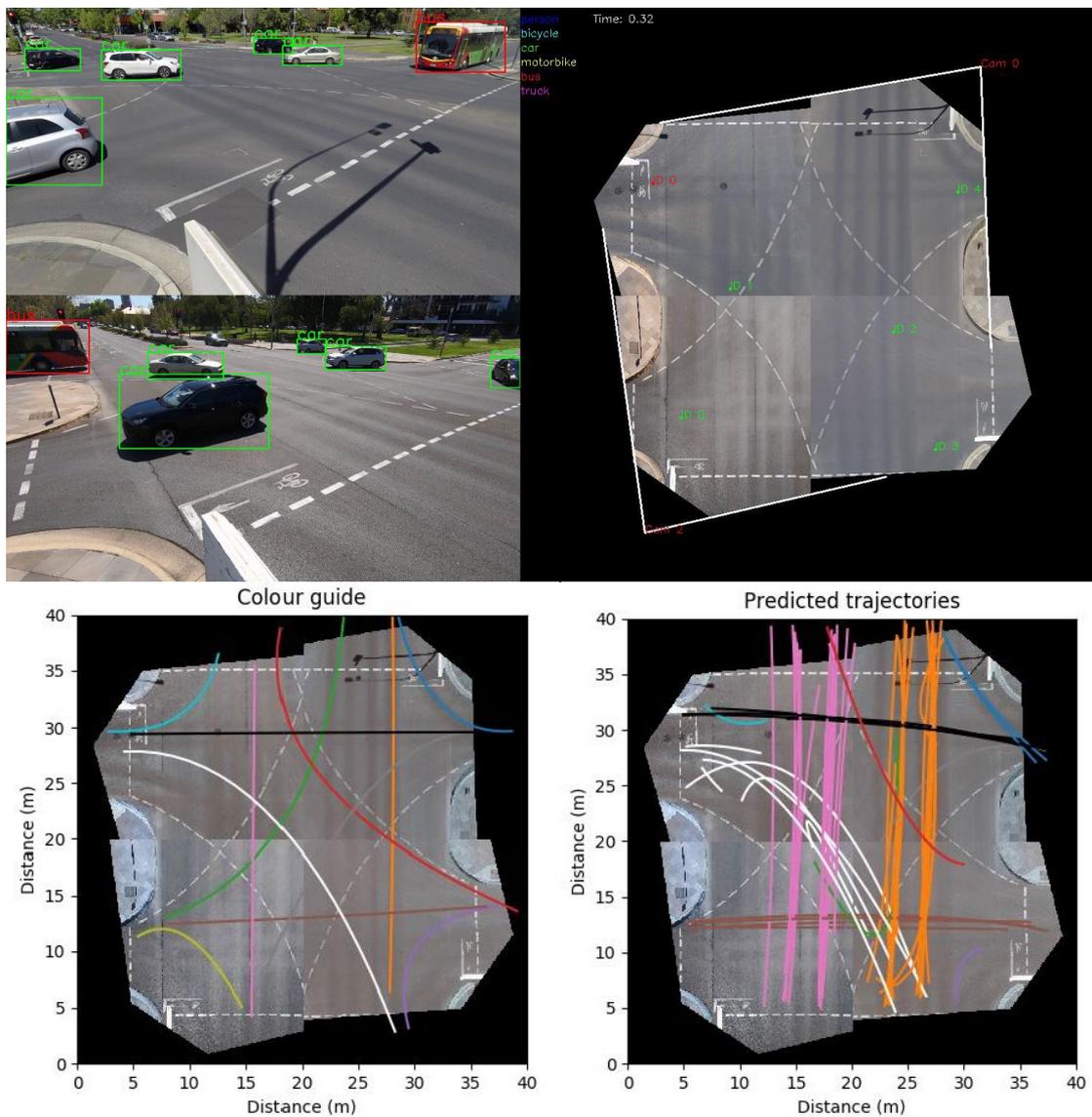
The current system can identify road users including pedestrians, cyclists, motorcyclists, cars, busses and trucks, track vehicles across the intersection, determine the exit and entrance locations, and the

average/instantaneous speeds. This ability is proven in ideal conditions, there are limitations in difficult lighting conditions such as dawn/dusk/night and during severe weather. Large intersections also pose a challenge due to the high diversity in scale of objects that need to be detected. To extract speeds the camera system needs to be carefully calibrated. These are considerations when implementing a system of this kind.

Figure 1 shows the output of the system with the detections overlaid on the bird's eye view. Smoothed trajectories of detected cars are shown below with colour coded trajectories based on the predicted entrance/exit locations.

**Conclusions**

New methods of data collection offer unique opportunities to draw conclusions on safety without prior knowledge in short time frames, validate compliance with current methods of developing safe roads, and test the effectiveness of new treatments. Computer vision gives the capability to extract rich trajectory data as well as information on the road user types which can give deeper insights into operational effectiveness and safety of roads.



**Figure 1. Output of the system developed**

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## **Safe System for Universities: Safe System education for tertiary engineering students update**

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### **Abstract**

Safe System represents long-established best-practice in road safety internationally and in Australia and New Zealand. However, there has been limited success implementing Safe System policy into practice. While Safe System theory is taught at some Australian universities, there are currently no consistent means of formal education before professionals enter the workforce, leading to a discrepancy between graduate engineer knowledge and industry best-practice. Here, we present an update to the Safe System for Universities (SS4U) project, which provides a means for consistent education of Safe System theory at a tertiary level.

### **Background**

The Safe System philosophy, adopted in many countries and underpinning Australian and New Zealand road safety strategy, represents long-established leading-practice in road safety. Despite good intentions throughout the industry, there remains a gap between Safe System policy and its implementation at a practical level (Woolley and Crozier 2018). This “implementation failure” is being observed as a gap between the Safe System philosophy that we aspire to and the real-world outcomes that we achieve.

Safe System implementation is currently industry led once a graduate reaches the workforce, with no consistent means of formal education prior to employees graduating university. While the Safe System is taught as part of road transportation engineering courses within some Australian Universities, there is significant variance in breadth and depth of the content covered (pers comm with various tertiary educators). This lack of formal training has resulted in new graduates entering the road transportation industry lacking industry leading-practice knowledge, which has the potential to delay or hinder advancements in Safe System implementation into the future (pers comm road agency reps).

### **Method**

SS4U is an initiative of the Transport Accident Commission of Victoria (TAC) and Regional Roads Victoria (formally VicRoads) Safe System Road Infrastructure Program (SSRIP), being developed with the expertise of the Centre for Automotive +Safety Research, University of Adelaide (CASR) in collaboration with the New Zealand Transport Agency (NZTA). An introduction to SS4U was presented at the Australasian Road Safety Conference in 2019. Please refer to Stokes et al. (2019) for further details about SS4U. Here, we will provide an update to the SS4U project and future directions that are being pursued.

### **Results**

All four SS4U modules have been publicly released by the TAC through the Road Safety Education Victoria website (<http://www.roadsafetyeducation.vic.gov.au/teaching-resources/tertiary-education>). The first module is aimed at first year engineering students and covers general engineering safety. This module comprises six self-learning ‘snippets’, which each cover a core topic relevant to the ethics, principles and practice of engineering safety. This module also includes tutorials and case

studies for students to apply knowledge they have gained through the module. Modules two, three and four have a similar format. They focus solely on leading practice in engineering safety for road transportation. In Module 2, students are guided through an introduction to the Safe System, its guiding principles, objectives and how it has so far been integrated into Australian and New Zealand road safety practice. In Module 3, students learn about the practical side of the Safe System through an introduction to the practical measures for treating the most common crash types leading to severe injury. In the final module, students are exposed to the pragmatic issues associated with the Safe System, such as reconciling the ideals and reality of the Safe System, barriers to achieving the Safe System and how we may achieve widespread implementation.

The TAC is leading a plan for integrating SS4U into current tertiary education courses. To date, several Australian and New Zealand universities have registered interest in the project, with four universities in Victoria having been consulted as to their specific interests and future steps that will be required to facilitate integration into their courses. Feedback from these sessions is being used to inform future developments, such as enabling integration with standard online teaching platforms, providing instant-response online questions and stand-alone face-to-face lecture material.

In 2020, SS4U was trialed as part of the University of Adelaide final year traffic engineering and design course, with over 140 students participating in the course. Six students provided feedback with all assessing SS4U as improving their knowledge of the Safe System and being a benefit to their engineering education. The short, interactive format of the learning material was also well-received.

## **Conclusions**

SS4U has been conceived as a means for providing consistent learning and teaching information for undergraduate engineering studies in industry best practise for the Safe System. The SS4U project is currently being delivered to universities and feedback is informing improvements to the project.

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## Evaluation of yellow line marking and variable speed limit signs to improve safety in roadwork zones in NSW

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<sup>a</sup>Transport for NSW (TfNSW) 1, <sup>b</sup>Australian Road Research Board (ARRB)

### Abstract

To improve safety outcomes for road users and workers Yellow Line Marking (YLM) and Variable Speed Limit Signs (VSLS) were trialed with existing traffic controls in NSW roadwork zones. TfNSW commissioned ARRB to evaluate these initiatives by synthesising the findings from a variety of documents, data and other field based evaluations to determine if these initiatives should be deployed on an ongoing basis. For YLM, the positive safety benefits appear to be outweighed by the costs to implement and effort required to maintain. Additional robust evaluation and evidence would be required to quantify its benefits and justify implementation. VSLS benefits were more apparent, including the impact on driver adherence to speed limits, improved driver attention and reduced safety risk for workers. There seems to be value in continuing its use under controlled conditions to assess ongoing impacts. This evaluation approach could be applied by other organisation's evaluating traffic control initiatives.

### Background

YLM and VSLS were trialed as part of traffic control at roadworks during construction of the Pacific Highway Woolgoolga to Ballina upgrade. YLM were applied to improve drivers differentiation between a work zone and adjacent roads and increase driver attention where road conditions had changed. The VSLS were trailer-mounted and remotely-activated. VSLS were used to improve speed sign visibility with a view to increasing driver compliance with work zone speed limits, and reducing the risk of exposure to traffic by workers manually changing signs.

A range of data sources were collected to evaluate the trials, including literature reviews, crash data, speed surveys, driving data, operational data (including road safety audits), and self-reported surveys and interviews. Components of the evaluations included community feedback surveys, and surveys and interviews with heavy vehicle drivers. Studies were also conducted involving community members driving an instrumented light vehicle through the initiatives.

The objective of this project was to collate, analyse, synthesise and make suggestions based on the overall evaluation findings to support decision-making as to whether there was evidence to support YLM and/or VSLS as ongoing safety initiatives.

### Methods

Table 1 provides a summary and description of each of the data and documents evaluated for each initiative.

### Results and Conclusions

The evaluation identified a high level of community and driver support, but this was unlikely to impact their driving behaviour. The instrumented vehicle study found driver behaviour, such as speed and lane keeping, was generally not negatively impacted by YLM in roadwork zones, and drivers reported YLM were more visible than white lines. Limitations identified were the potential

to cause driver confusion, relatively high cost compared to white line marking, wearing quicker and associated issues with visibility once this occurred in certain weather conditions and at night.

The assessment of road safety impacts associated with YLM in roadwork zones was inconclusive and considered any positive safety outcomes of YLM may be outweighed by the costs of implementation an ongoing maintenance. If future use of YLM in roadwork zones were considered, it is recommended additional robust evaluation be undertaken of the impact of YLM on crash risk and speed to quantify longer-term benefits.

The benefits of VSLS were apparent, including its impact on drivers' adherence to the speed limit in the 'short term' (Bitzios 2018), improved driver attention (ARRB 2018), and elimination of the need for workers to manually install, remove, cover or uncover speed signs. The key limitations of VSLS identified in this evaluation were the difference in short and medium-term impacts on speed compliance (Bitzios 2018) and confusion when VSLS signs are blacked out (RMS 2017b). These benefits increase the likelihood they will become a mainstream device and a component of traffic control.

As VSLS are used at roadwork zones further data collection to optimise their integration into a work zone with complementary traffic control is suggested. This methodology may be of value when reviewing the effectiveness of other traffic controls at roadwork zones to enable robust and reliable evaluations to investigate safety benefits.

**Table 1. Data schedule summary**

Data Type	Rationale	Intervention & Material	
		YLM	VSLS
Literature reviews	To obtain research on the effectiveness of these initiatives to improve safety from other research and jurisdictions.	Literature review report provided by ARRB as Task 2 of this project (ARRB 2019a). 118 records were identified and screened with 17 studies included for qualitative analysis (10 VSLS & 7 YLM).	
Crash data	To determine if the initiatives had an impact on improving crash rates using data from the CrashLink database.	Chatsworth Island to Maclean site between 1 January 2014 and 31 December 2018.	Broadwater site between 21 August 2013 and 28 February 2018.
Speed data	To determine if the initiatives had an impact on drivers' speed compliance.	4 sites on Harwood Island between 2 and 8 April 2019. Data was collected at four locations over a one week period, 2 with YLM and 2 with white lines.	Speed analysis findings report (Bitzios 2018). Speed data comparison of vehicle speeds at three locations during the 'Before (Pre-VSLS)' and 'After (Post-VSLS)' scenarios was assessed for key findings.
Instrumented vehicle studies	To understand the initiatives from drivers' perspectives using both quantitative and qualitative information.	Instrumented vehicle study findings (ARRB 2018). 22 participants drove through roadwork zones on the Highway in an instrumented vehicle while verbalising their thoughts and decision making.	
Community Surveys	To obtain community members feedback about the initiatives following educational campaigns.	Community feedback report (Roads and Maritime Services (RMS) 2017a). A total of 333 people responded to the survey.	Community feedback report (RMS 2017b). A total of 83 people responded to the survey.
Heavy vehicle drivers interviews and survey	To understand HV driver's perspectives on benefits, risks and issues related to the initiatives.	Heavy vehicle driver survey report (ARRB 2019b). A total of 4 HV drivers completed an in-depth interview and 31 people responded to the survey. Respondents were required to have driven through the trial sites where YLM and VSLS were implemented.	
Operational documents	To understand the practical and operational impact of the initiatives. To quantify economic impacts for a cost benefit analysis.	Key documents included for review were Traffic Control Plans, Safety Change Risk Assessments and Road Safety Audits & Concept of operations documents.	
Video data	To determine changes over time.	Video drive through footage between Iluka and Maclean.	

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## **Responsivity and innovation in road safety education: are we listening to our audience?**

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### **Abstract**

As part of Transport for NSW's (TfNSW) Road Safety Education Program, *Kids and Traffic* works with early childhood organisations to support families and communities to improve safety outcomes for children. Ongoing engagement with early childhood and other key stakeholders enables responsive, evolving and strategic delivery of the Program within a double loop learning framework, driving creativity and innovation (Synnott, 2013). Evidence-informed responsivity to emerging social and educational trends and the needs and interests of stakeholders ensures *Kids and Traffic* maintains its relevance and position as a valued, trusted provider of road safety education professional learning and resources. Initiatives that address barriers to engaging early childhood services, families and communities in road safety education increase Program reach and effectiveness. Development of innovative approaches to road safety education which respond to the needs and interests of stakeholders supports the Program's goal of zero child road trauma.

### **Background**

Transport related injuries remain a leading cause of death in children under 14 years of age in Australia (Australian Institute of Health and Welfare, 2020). *Kids and Traffic* is part of TfNSW Road Safety Education Program, an enduring, shared-governance partnership with TfNSW, NSW Department of Education, Association of Independent Schools NSW and Catholic Schools NSW. *Kids and Traffic* helps organisations identify local road safety issues and develop effective community-specific solutions. The Program supports collaborative grassroots action at a local level to prevent child road trauma. For over twenty-five years the *Kids and Traffic* Program has provided road safety professional learning workshops, educational resources, advice, support and advocacy to early childhood services.

### **Purpose of strategy**

*Kids and Traffic* seeks to prevent child road trauma by partnering with early childhood organisations and other stakeholders to improve safety outcomes for children, families and communities. The Program monitors, evaluates and responds strategically to changing social and educational trends impacting early childhood services, children, families and communities. Responsivity to the evolving needs and interests of the early childhood sector is crucial to maintaining Program uptake and supporting ongoing engagement with over 3500 early childhood organisations across NSW.

### **Description of strategy**

*Kids and Traffic* is informed through ongoing communication and joint-collaboration with early childhood educators, the Program's target audience. Workshops and resources are framed by the Australian Government's Early Years Learning Framework, National Quality Standard and aligned with the Australian Professional Standards for Teachers. Ongoing, active engagement with the early childhood sector allows *Kids and Traffic* to leverage off current educational trends and develop innovative approaches to road safety education. Listening and responding to emerging needs in the sector is crucial to maintaining relevance and a position as a valued, trusted provider of ongoing professional learning and resources. Development of additional *Kids and Traffic* workshops linking

road safety to science, technology, engineering and mathematics (STEM) curriculum and to environmental sustainability are examples of this responsive, yet proactive, approach.

Identifying barriers to reaching and sustaining educator, family and community engagement in road safety education and analysing gaps in Program provision requires regular evaluation. Revising Program delivery modes and developing novel content and resources allows *Kids and Traffic* to effectively connect with new audiences. This is evidenced by Program engagement with family support services, playgroups and early intervention settings and the *Kids and Traffic* library project which seek to reach children and families not utilising formal early childhood education and care settings.

## Conclusion

*Kids and Traffic*, like many other child safety programs, consults with key stakeholders to determine Program content and materials which address key safety messages. Crucially, in addition to this, *Kids and Traffic* consistently engages with target audiences to maintain relevance and uptake in local communities. Along with educator's interests and evidence-informed evaluation of trends in education this guides Program evolution and growth. Commitment to innovation, agility, critical analysis and, most importantly, to listening to the needs and interests of stakeholders supports the Program's goal of zero child road trauma.

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## Future Light Vehicle Safety Priority Areas in Australia

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<sup>a</sup>Monash University Accident Research Centre

(See also: <https://doi.org/10.33492/JRS-D-21-00001>)

### Abstract

This analysis aimed to identify future priority action areas for light vehicle safety by identifying fatal crash types that will not be fully addressed in the future by projected improvements in active and passive safety in the light vehicle fleet. Modelling the likely future crash profile of the light vehicle fleet in Australia identifies target areas for future vehicle design and technology improvements that will assist in achieving the goals of Towards Zero.

Analysis identified four priority areas: (i) fatal pedestrian crashes, (ii) single vehicle frontal crashes with fixed objects, (iii) front-to-front vehicle crashes and (iv) front-to-side impacts, including straight crossing path and right turn across path crash types.

Suggested countermeasures include the investigation mechanisms to improve the natural penetration of key driver assist technologies, particularly in light commercial vehicles, as well as new or enhanced technologies targeting crashes involving intersections, speeding, fatigue, distraction, pedestrians and bicycles.

### Background

This analysis aimed to identify future priority action areas for light vehicle safety by identifying crash types that will not be fully addressed in the future by projected improvements in active and passive safety in the light vehicle fleet. Modelling the likely future crash profile of the light vehicle fleet in Australia identifies target areas for future vehicle design and technology improvements that will assist in achieving the goals of Towards Zero. This analysis is novel in that it models the combined effects of vehicle safety technologies and vehicle design using the most recently published real world active vehicle technology effectiveness estimates, and projections of crashworthiness, technology fitment and crash populations based on recently available real-world data.

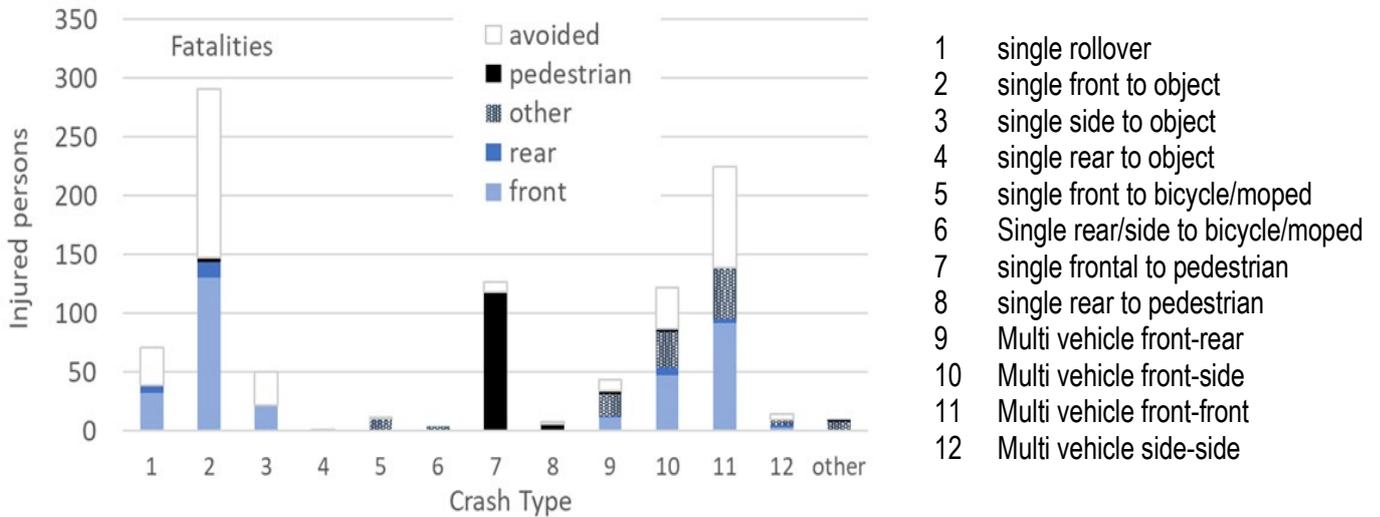
### Method

Light vehicle involved, injury crash data from 2016 was projected to 2030 maintaining current vehicle age and market group distributions. Fitment of active vehicle technologies was projected to a 2030 year of manufacture using logistic regression modelling of safety technology fitment data provided by Redbook. Published evaluations of active vehicle safety technology effectiveness were used to identify crash types involving light vehicles mitigated by active vehicle technologies, and the estimated proportion of those crashes that were prevented. The reduction in remaining fatal and serious injuries was then estimated using projected crashworthiness ratings to reflect the influence of future passive safety technologies and vehicle design. Results of the analysis produced estimates of the expected proportions of injuries and crashes remaining by location, road user, market group and crash type in 2030 compared to 2016.

### Results

The light vehicle involved crash population was partitioned into twelve crash types based on vehicle impact points, vulnerable road user involvement and number of motor vehicles involved. Figure 1

lists the 12 crash types considered with the full bar height in the figure showing the number of fatalities resulting from each in 2016. The colored bar heights in Figure 1 give the estimated number of fatalities from each crash type that are estimated to remain in 2030.



**Figure 1. 2016 fatalities by road user, crash type and 2030 avoidance**

Four future vehicle safety priority areas were identified from the analysis: pedestrian crashes, single vehicle frontal crashes with fixed objects, front-to-front vehicle crashes and front-to-side impacts including straight crossing path and right turn across path crash types. These crash types were projected to be the largest contributors to fatalities by 2030. Remaining crash types in 2030 will be poorly addressed by current vehicle safety technologies.

**Conclusions**

This analysis highlighted the limitations in fatality reductions related to the natural penetration of vehicle safety technology fitment. Significant numbers of fatalities resulting from intersection crashes, single vehicle run off road and head on crashes will remain whilst pedestrian crashes will grow in their proportionate importance. Additional or enhanced vehicle safety technologies will need to be developed that better address these crash types. In addition, means to address the key remaining crash types elsewhere in the system need to be considered through measures such as road infrastructure treatments and appropriate speed limit setting for high risk environments where vehicle safety technology proves inadequate.

## Characteristics of crash-involved drink and drug drivers and motorcyclists

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### Abstract

This study examined the characteristics of 1,277 hospitalised road users in South Australia in the years 2014 to 2017, with reference whether they tested positive to alcohol or other drugs (the three drugs prescribed in the South Australian *Road Traffic Act (1961)*: THC, methamphetamine, and MDMA). This examination used a database combining hospital data, police-reported crash data, licensing information, and the result of alcohol and drug tests conducted by Forensic Science SA. Findings include: that those combining drugs and alcohol only comprise a small proportion of hospitalised motorists; that drivers are more likely to test positive to alcohol or methamphetamine, while motorcyclists are more likely to test positive to THC; drug and alcohol positive motorists tend to exhibit a range of other risky behaviours, and also tend to sustain more severe injuries in the event of a crash.

### Background

Drug driving is an issue of growing concern across many Australian jurisdictions (Commonwealth of Australia, 2018). The primary approach to the drug driving issue throughout Australia has been the establishment of roadside drug testing (RDT).

It is important that this program of enforcement is evaluated (Baldock & Woolley, 2013) and also important that it is informed by sound evidence regarding patterns of impaired driving. To this end, the present study examines the results of drug testing of South Australian motorists admitted to hospital following a road crash.

### Method

The data used in the present study were collected for road users who were injured in a road crash and were admitted (four hours or more) to the Royal Adelaide Hospital (the major trauma hospital in South Australia) over the time period of April 2014 to October 2017. Data were matched for each case from medical records, the police reported crash database, licensing records and the results of alcohol and drug testing.

### Results

Briefly, the study found that a quarter of hospitalised drivers or motorcyclists were positive to alcohol or drugs (see Table 1). Drugs were found more commonly than alcohol, while just over 2% of motorists were positive to both alcohol and at least one of the three prescribed drugs. Drivers were more likely to record an illegal BAC and to test positive to methamphetamine while motorcyclists were more likely to test positive to THC. Drunk drivers tended to have a higher BAC than drunk motorcyclists.

Group comparisons (see Table 1) revealed that motorists who were positive to alcohol or drugs, compared to those who were alcohol and drug free:

- were more likely to be at fault for the crash,

- were more likely to have a restricted licence or to be unlicensed (especially those positive to both alcohol and drugs),
- were less likely to be wearing a seatbelt,
- were more likely to have prior traffic infringements (especially drug positive drivers),
- sustained more severe injuries, and
- had longer hospital stays.

*Table 1. Alcohol and drug test results for hospitalised motorists in SA, 2014-17*

Road user group	Number	Percentage	Mean BAC
No alcohol or drugs - drivers	673	52.7	
No alcohol or drugs - motorcyclists	314	24.6	
Drink drivers	77	6.0	0.156
Drink motorcyclists	17	1.3	0.124
Drug drivers	110	8.6	
Drug motorcyclists	58	4.5	
Drink and drug drivers	24	1.9	0.148
Drink and drug motorcyclists	4	0.3	0.104
<b>Total</b>	1277	100.0	

In regard to injury patterns, drunk drivers tended to sustain more severe injuries to the head/neck, face and chest than other road users in the sample, while motorcyclists in general were more likely to sustain injuries to external regions or the extremities.

## Conclusions

In South Australia, prescribed drugs are now associated with a greater proportion of road trauma than alcohol, a reversal of the long established trends. Drivers/riders combining alcohol and prescribed drugs contribute to only a small proportion of road trauma, however, and so probably do not deserve any special attention in terms of enforcement or policy action. Drivers of cars (alcohol, methamphetamine) and motorcyclists (cannabis) exhibit different patterns of drug use. Those motorists who drive or ride when positive to alcohol or drugs are likely to exhibit other road use behaviours that are risky or indicative of a lack of care (e.g. no seatbelt, unlicensed, other infringements). Enforcement related to drink and drug driving remains important, as, in addition to higher crash risks, the injuries sustained by alcohol and drug positive motorists in crashes tend to be more severe.

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## **Joe Rider Motorcycle Safety Campaign – Cross-border road safety cooperation and implementation into local government regions**

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### **Abstract**

In 2016, QPRC first partnered with ACT Motorcycle Rider Association (MRA) to extend their ‘Joe Rider’ Motorcycle Safety Campaign into NSW regions. Adapted for local implementation with three local governments the project featured targeted strategies to local motorists about risks for motorcycle riders while encouraging local riders to ride safely. The campaign builds on ‘Look but failed to see’ crash research and aims to positively support riding in the region through increased awareness. From a successful pilot, the project was incorporated into QPRC Road Safety Action Plan and delivered annually from 2017-2020 involving stakeholder involvement of local rider trainers Stay Upright and Australia Post. Fostering ongoing cross-border collaborations the project capitalizes on region-wide impact of a shared approach while benefiting from local implementation. While there are challenges to cross-border collaborations the benefits have been realized through increased reach and participation from local motorists on each successive implementation of the campaign.

### **Background**

Motorcycle crashes are over-represented on QPRC roads. 2016 ABS<sup>1</sup> statistics recorded motorcycle registration for QPRC as 5.4% of total registered vehicles but motorcycles involved in 14% of QPRC casualty crashes<sup>2</sup>. ABS<sup>1</sup> statistics indicated popularity of motorcycles was increasing with 1983 registered motorcycles in Queanbeyan in 2011, jumping to 2578 registered motorcycles by 2018. Detailed crash analysis indicated crash factors for QPRC motorcycle crashes were males aged 17-25 years and 40-49 years with local riders featuring predominantly in crashes – 69% of motorcycle casualty crashes involved riders from Queanbeyan LGA<sup>3</sup>.

In February 2016 ACT Chapter of ACRS hosted “Riding Rural Roads” Forum. Associate Professor Kristen Pammer from ANU presented current research<sup>4</sup> on ‘Look but fail to see’ (LBFTS) factors and “Inattentional Blindness” contributing to motorcycle crashes stressing importance of training drivers to be motorcycle-aware.

The forum connected road safety staff from NSW local governments with ACT MRA to explore possible expansion of their ‘Joe Rider’ Motorcycle Safety Campaign. With permission from ACT MRA business cases were examined and funding applications lodged with NSW Government to expand “Joe Rider” into QPRC, GMC and ESC using similar approaches of ACT campaign but adapting implementation to suit local conditions. The regional approach aimed to capitalize on evidence-based campaign promoting motorcycle rider awareness while harnessing the reach of region-wide implementation to benefit all participating jurisdictions.

### **Method**

QPRC initially partnered with Stay Upright Rider Training with five trainers wearing the ‘Joe Rider’ vests on local streets. This vital partnership assisted the campaign’s dual message, encouraging local riders to be safe on roads while promoting the ‘awareness’ factor and providing prizes for recorded sightings of ‘Joe Rider’. Each year the reach and participation of the campaign has expanded with motorist encouraged to report all motorcyclist sightings online during the campaign. Campaign safety messaging is distributed via local media, Council’s communication

network and involvement of local motorcycle retailers. The last two years have seen a region wide promotion in Canberra Weekly with a reach of 96,400 readers.

As motorists are asked to report their sighting online safety messaging about ‘Don’t Text While Driving’ is included.

## Results

A cross-border collaboration with multi-jurisdictions has challenges but ‘Joe Rider’ has overcome obstacles and proved successful for QPRC with four consecutive implementations from 2016-2019 each resulting in an increased participation and reach.

Implemented in October, when ‘Motorcycle Safety Week/Month’ activities are run by ACT/NSW Governments, it has enabled QPRC to forge partnerships with key motorcycle safety stakeholders and provides a mechanism for Council to hold safety dialogue with the community about motorcycle riding.



## Conclusion

Recent crash analysis for QPRC highlighted the importance of continuing the dialogue with the community on motorcycle safety with motorcycle crashes contributing to 18.3% of QPRC FSI crashes<sup>5</sup>. 2019 study<sup>6</sup> further supported the importance of continuing to raise awareness of motorcyclist presence on road to avoid their over-representation in crashes and their proposed ‘Saw but Forgot’ (SBF) error with recommended PRC model will be reviewed for possible inclusion in future ‘Joe Rider’ safety campaign messaging.

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## Pedestrian Safety at Traffic Signals

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### Abstract

While traffic signals are relatively safe for pedestrians (compared with other intersection forms of control and mid-blocks) there are still a significant number of fatal and serious crashes at these intersections in New Zealand. It is challenging to achieve safe system at such intersections given most are located on arterial roads and therefore have a 'traffic movement' function. Lower speed limits to achieve operating speeds of 30km/h or less are not always viable at these intersections except where there is also a high place-making function, such as CBDs and larger activity centres. Severe pedestrian crashes at traffic signals are often a result of either a pedestrian or a driver not obeying the signal phasing. This is especially the cases when a pedestrian is being struck by a vehicle traveling straight through the intersection (either at the pedestrian crossing or on the intersection approach). To address these crashes, it is important to understand the factors, including behaviours, behind jaywalking and red light running. These factors vary from intersection to intersection and by time of day. A better understanding of these factors will assist in reducing road trauma.

### Literature Review

Turner et. al. (2006 and 2012) examined many of the factors that impact on pedestrian crashes. These studies identified that the volume of vehicles and pedestrians was the strongest factor and there was a large safety-in-number effects in terms of pedestrian volumes. Other predictor factors included the proportion of pedestrians crossing on the green man (or not jaywalking), the signal cycle time/wait time, pedestrian crossing width, the signal phasing type and number of through lanes that right turners cross, all-red time, presence of a raised median and use of split phasing. Turner (2006) also collected information on jaywalking behaviour (data on those crossing on green, red and flashing red man and on intersection approach) by time-of-day at approximately 250 traffic signals. This information shows that the jaywalking varies depending on traffic volume using the intersection. During busy periods there is less jaywalking due to less gaps in the traffic. The research findings in these studies will be pulled together with research from other international studies to identify the key factors that impact on pedestrian safety.

### Methodology

This study assessed how safety might be improved for pedestrians at traffic signals. It includes an analysis of pedestrian crashes at traffic signals in Christchurch and Auckland. A more detailed crash analysis has been undertaken at a sample of signalised intersections, including prediction of the current level of pedestrian crash risk using the crash prediction models and for potential improvement options. Further surveys of jaywalking are planned at a sample set of sites, to see if there have been any changes in jaywalking behavior since the 2006 study was undertaken and to observed distracted pedestrians (which are likely to have gone up with mobile phone use).

The second part of the methodology involves a discussion on safety surrogate measures to assess level of risk for pedestrians at traffic signals. Two key safety performance indicators (SPI) that will be assessed are the level of jaywalking at and around each intersection and prevalence of red light running. Methods to reduce these SPIs across the safe system will be discussed.

## **Conclusion**

The key outcome from this study is a clearer understanding of what factors impact on pedestrian crashes, especially the more severe crashes, at traffic signals. It will discuss the need for development and monitoring of safety performance indicators (or surrogates for crashes). It will explore the link to poor driving and crossing behaviours along with measures to address these matters. This is likely to include infrastructure improvements, improving signal operation, education and enforcement of traffic rules.

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## **Epidemiology and Injury Profiles of Single Vehicle Motorcycle Fatalities in Tamil Nadu, India, 2009-2017.**

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**Background and Objectives:** Road traffic injuries continue to be a public health concern and the leading cause of death killing more than 1.35 million people around the world. Low and Middle-Income Countries (LMIC's) account for nearly 93% of the road fatalities whereas accounting for only 60% of the total registered vehicle on the road. The burden of risk in the developing economies was found to be 3 times higher compared to that of developed economies as per the global status report by WHO (WHO, 2018).

In India's (an LMIC country) road traffic, there are about 4,50,000 road accidents every year with more than 1,50,000 deaths accounting for almost 11% of total accident-related deaths in the world. According to the report by the Ministry of Road Transport and Highways (MoRTH, 2018), there were around 1,64,313 motorcycle crashes resulting in 1,53,585 injuries and 47,560 deaths

Single-vehicle crashes which do not collide with other vehicle or pedestrians which are involved in an accident due to causes such as self skidding, hitting stationary objects, trees which is simply contributed by the drivers themselves. Such type of accidents which are contributed by the drivers themselves. The influence of roadway and environmental factors play a major role in these crashes.

Single-vehicle crashes account for a large proportion of fatal accidents. In India, a significant proportion of accidents are single-vehicle motorcycle crashes. However, a clearer picture with respect to single-vehicle crashes in these motorized two-wheeler crashes is unavailable. Motorized two-wheelers include motorcycles, scooters and electric bikes. Due to the complex and relatively poor road environment in India, the most common type of conflict in which the rider is killed or injured is a crash involving two-wheelers.

Extensive research has been carried out to investigate the risk factors and patterns associated with single-vehicle motorcycle crashes. Data presented show a growing number of motorcycle deaths in Tamilnadu, but also a swift progression single-vehicle motorcycle crashes, making the state apropos for exploration of drivers killed over a 9-year period. The research questions which guided the study include (1)What is the epidemiology of single-vehicle motorcycle crashes in Tamilnadu in terms of person, place and time?, (2) What are the injury nature and injury profile (injury mechanism) of motorcyclists involved in fatal crashes? and (3)What are the collision nature and driver error for the fatal crashes reported?.

**Data and Methodology:** RADMS (Road Accident Database management System) database, is the official source of crash data containing detailed information as well as linked with hospital data is managed by the state transport planning cell of Tamilnadu is used in this study. All the motorcycle crashes reported from 2009 to 2017 which resulted in fatalities among which single-vehicle crashes alone were extracted from the database. A total of 16,542 crashes resulted in injuries occurred during the time period among which 7,448 were fatal crashes. In all cases, the motorcyclists were found to be at fault. Due to underreporting of no injury/property damage only, they are neglected in the current study.

**Results:** Over a nine-year period under investigation, authors found that male (99.2%) motorcyclist was clearly more at risk compared to female counterparts in fatal cases. The most frequent group of fatally injured motorcyclists were those aged between 26-55 years (working age group) (70.99%)

followed by motorcyclists between 18- 25 years (Young adult drivers) (25.46%). With respect to the time of the crashes, just over 53% of crashes occurred in the daytime.

Cross tabulations indicated that highways (4773 out of 7448 cases) were the major spots for fatalities to occur. Five metropolitan districts (Chennai, Coimbatore, Villupuram, Tirunelveli, and Tuticorin) accounts for 32.3% of all fatal injuries in the state. When exploring the nature of the collision, a clear representation emerges. Skidding (2925 out of 7448 cases) is found to be a single large contributor to fatalities in single-vehicle motorcycle crashes followed by hitting fixed objects on road.

Assessing the cases for the cause of fatal crashes revealed that among the driver errors, violation of traffic rules (3301 out of 7448) was found to be the single largest contributor. However, the cause of driver error was clearly unknown among 2192 cases whereas 1276 cases were not the error of the motorcyclists. Considering the maneuver of the vehicle at the time of crashes, it was found that crashes occurred when the motorcyclists went ahead of the other vehicle (29.98%) followed when diverging/merging with the traffic stream (28.57%).

Analysis of injury information identified in single-vehicle crashes, motorcyclist's most commonly sustained head injuries (51.27%). Injuries to the multiple body parts (20.13%), leg (3.26%) and hand (3.18%) were also commonly reported. With respect to the injury nature which resulted in fatal outcomes among motorcyclists were severe coma (28.26%), followed by wound/cut (22.3%) and cranial trauma (9.43%).

**Conclusions:** The results of the research show that the risk of male drivers and their violation of rules may pose a higher risk of fatal injuries. Both young and middle-aged drivers are prone to more fatal crashes compared to the elderly population. In respect of road protection measures, more attention has to be given to young and middle-aged people, study the behavioral aspects of motorcycle riders, analyze the psychological activities to identify the cause of the crash and develop effective countermeasures for reducing fatalities. Further studies should investigate specific circumstances involving interaction terms that reveal the detailed conditions and causation of the crashes.

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## **Analysis of injury severity in single-vehicle four- wheeler crashes with drivers being at-fault in Tamil Nadu, India.**

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**Background and Objectives:** Single-vehicle crashes are of major concern in both developed as well as developing nations due to the severity of injuries it results in. Several studies in the past have highlighted that single-vehicle crashes account for a large proportion of fatal accidents. In India, a significant proportion of accidents are single-vehicle crashes. According to the report by the Ministry of Road Transport and Highways (MoRTH, 2018), a total of 4,67,044 accidents have been reported by the states and union territories in which have claimed 1,51,417 lives. However, a clearer picture with respect to single-vehicle crashes is unavailable.

Single-vehicle crashes are generally classified into two types: one in which the vehicle collides with the pedestrians and the other where the vehicle does not collide with other road users. The vehicles which do not collide with other vehicle or pedestrians which are involved in an accident due to causes such as self skidding, hitting stationary objects, trees which is simply contributed by the drivers themselves. Such type of accidents which are contributed by the drivers themselves is referred to as out-of-control single-vehicle crashes. The influence of roadway and environmental factors play a major role in these crashes.

The objective of the present study is to obtain a clearer understanding with respect to the injury severity of the out-of-control single-vehicle four-wheeler crashes with the drivers being at fault. Contributory factors including driver, roadway, and environmental characteristics are investigated and discussed.

**Data and Methodology:** Crash dataset for the present study was prepared from the police reported single-vehicle crashes for the past nine years that occurred within the state of Tamilnadu. The research team retrieved all the single-vehicle out-of-control four-wheeler crashes for the period between 2009 and 2017. To focus on the prime objective of this study, the research team identified contributory factors that influence the severity of crashes. The identified variables include driver characteristics (driver gender, age, license status, alcohol/drug status, driver error, at-fault status), crash-related factors (accident severity, collision type, presence of median separators, number of lanes, road category, road conditions), traffic-related factors (traffic movement, traffic control), vehicle (vehicle maneuver) and environment-related factors (population setting, weather condition, light condition, region, season, day of the week and location).

In this study, the KABCO scale developed by NSC was used. Due to the low frequency of some crash severity categories using the KABCO scale, Injury(B non-capacitating) and (C-Possible injury) cases were combined together and referred to as simple injuries. Due to underreporting of no injury/property damage only(PDO), such crashes are neglected in the current study. Finally, we had three categories: fatal, grievous and simple injuries.

The injury severity level of the accidents is in the form of a series of ordinal levels such as simple injuries, grievous injuries, and fatal injuries. To deal with that of the ordered categorical variable, ordinal logistic regression analysis was carried out. A major assumption is that slope coefficients are the same across response variables which are called proportional odds assumptions. The brant test was carried out to check for the assumption being valid or not. The result (Chi-squared =58,  $p>0.05$ ) indicated that ordered logit coefficients are equal across the levels of outcomes without violating the proportional odds assumption.

**Results:** The results show that the number of factors was found to be significant. Compared to younger drivers, young adults (OR=3.22;95%CI=1.11 - 9.30) and adults (OR=3.21;95% CI=1.11-9.26) are associated with the risk of severe injuries. With respect to driver errors, violation of rules (OR=1.23;95% CI=1.08-1.40) is significantly associated with high severity levels among four-wheeler crashes. Considering the vehicle maneuver at the time of the accident, parked /parking of vehicle (OR=0.56;95% CI=0.34-0.91) is associated with low accident severity.

With respect to environmental factors, serious and fatal crashes are less likely to occur in summer season (OR=0.92;95% CI=0.85-0.99) compared to the monsoon season. Compared to central regions of Tamilnadu, in the south (OR=0.81;95% CI=0.73-0.90) and west region (OR=0.71;95% CI=0.64-0.78) of Tamilnadu serious and fatal crashes are less likely to occur. With respect to collision type, compared to animal hit crashes, hitting parked vehicles, hitting a tree, other collision types, hit from the rear, hitting a parked vehicle and ran off roads are found to be associated with less severity. Compared to multi-lane roads, single-lane roads (OR=4.85;95% CI=4.34-5.41) and two-lane roads (OR=1.39;95% CI=1.23-1.56) are often associated with high severity. The presence of median separators (OR=2.0;95% CI=1.86-2.16) is also often associated with more severe crashes.

Compared to district roads, highways (OR=3.49;95% CI=3.10-3.92) and village roads (OR=2.49;95% CI=2.09-2.97) pose a greater injury risk for single-vehicle crashes. With respect to population setting, rural roads pose a significantly greater risk for serious and fatal crashes compared to urban roads.

The modeling results show that some of the results were found to be consistent with the number of previous studies. Younger and working-age group drivers, violation of rules, number of lanes, presence of median separators, highways and village roads were found to be significantly associated with increased probability of higher injury severity.

**Conclusions:** Based on the findings of the above results, targeted countermeasures may be designed in light of the injury severity of the drivers. For example, drivers who violate the law are prone to more severe injuries, awareness to strictly avoid such behaviors and strict law enforcement is need of the hour in those crashes. Further, single-vehicle out-of-control four-wheeler crashes occur due to the road surface conditions or failure of control of the vehicle which increases the fatality of the drivers. Hence further studies should investigate specific circumstances involving interaction terms that reveal the detailed conditions and causation of the crashes.

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## Investigation of injury patterns in heavy-duty single vehicle crashes based on real-world accident data in Tamilnadu, India

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**Background and Objectives:** Road Traffic Injuries (RTI) has become a major public health concern killing more than 1.35 million people around the world. Low- and Middle-Income countries (LMIC) account for nearly 90% of the road traffic injuries though they account for only 60% of the registered vehicle on their roads. India, as a second populous nation in the world with 1355 million inhabitants, it has one of the highest risks of road fatalities in the world (WHO,2018)

Heavy-duty vehicles serve a vital function in any of the developing economies. In India, heavy-duty vehicles are defined as vehicles with gross vehicle weight over 11,793 kgs. These vehicles include bus, truck, tractor, and heavy articulated vehicle/trolleys. Crashes that involve these heavy-duty vehicles are more severe compared to other vehicle types because of size, weight and speed differentials. According to the Ministry of Road Transport and Highways (MoRTH) 2018 report, there were about 1,20,970 heavy-duty vehicle crashes which resulted in 1,25,097 injuries and 48,745 deaths.

In recent years, there has been an interesting interest in studying the contributory factors for single-vehicle crashes especially that of heavy-duty vehicles. Single-vehicle crashes are those crashes where vehicles do not collide with other vehicles or pedestrians, but due to causes such as self skidding, hitting stationary objects, trees which are simply contributed by the drivers themselves. The major reason for such crashes was identified to be caused by the influence of road and surrounding environment factors. In India too, a significant portion of fatal crashes are heavy-duty vehicle crashes which are contributed by the driver themselves. Hence, this study investigates the prevalence of heavy-duty single-vehicle crashes occurring in the state of Tamilnadu, India.

The present study also identifies the unique characteristics and injury outcomes associated with heavy-duty single-vehicle crashes. Research questions made curious for the study include (1) What is the epidemiology of the heavy-duty single-vehicle crashes in Tamilnadu in terms of location, persons, time? (2) What is the collision nature and driver-errors which contributed to the fatalities reported? (3) what are the injury nature and injury mechanism of heavy-duty vehicle drivers who were involved in fatal crashes?

**Data and Methodology:** Descriptive statistical analysis has been carried out to examine contributory risk factors and patterns associated with heavy-duty single-vehicle crashes. The dataset for this study was obtained from the accident database maintained by the state transport planning commission of Tamilnadu referred to as the RADMS database. It is the official source of crash data information present in the state which is linked with hospital data. After the preliminary investigation, a total of 35,373 single-vehicle crashes that occurred during 2009-2018 were retrieved for further analysis. Among those crashes, 4983 crashes were identified to be heavy-duty single-vehicle crashes. There was a total of 1322 fatal, 503 grievous, and 3158 simple injury crashes reported. Due to the underreporting of data in developing nations, vehicle damage and no injury crashes were excluded from the analysis.

**Results:** On examination of 10 years data, it was found that male (99.6%) drivers were at the risk of fatalities compared to female counterparts. Among heavy-duty single-vehicle crashes, the majority of the drivers belong to the working-age group between 26-55 years (83.5%) followed by drivers

between 18-25 years (10.3%). Further, single-vehicle heavy-duty vehicle crashes were more common during daytime (61%) compared to darkness with streetlights-on (13.8%).

Cross tabulations showed highways (39.2%) contributed the majority with respect to fatal crashes. Among the top five districts in the state which accounted for maximum fatalities were identified to be Villupuram, Thirunelveli, Thiruvannamalai, Thiruvalluvar, and Thanjavur. Inspecting the nature of the collision, a clear depiction emerges, skidding (23.4%) is the single largest contributor for fatalities in heavy-duty single-vehicle crashes. Following this, other collision types that majorly contributed include side swipe(5.3%), overturning(5.2%) and run-off road (3.8%).

Evaluating the cause of road traffic fatalities among single-vehicle heavy-duty crashes revealed that among driver errors, exceeded lawful speed (34.6%) which the violation of rule of law in the state. and was found to be the single largest contributor.

Analysis of injury descriptors in heavy-duty single-vehicle crashes showed that drivers most commonly sustained multiple injuries (13.2%) to various body parts followed by head injuries (12.2%) and hand injuries (2.6%). With respect to injury nature which resulted in fatal outcomes among heavy-duty vehicle drivers were wounds/ cut (12.2%) followed by severe coma (6.58%), and permanent disfigurement of head or face (4.23%), abrasion (3.5%), contusion (2.3%), cranial trauma (2.0%)

**Conclusions:** This study provides useful insights into the contributing factors in case the heavy-duty of single-vehicle crashes. Recommendations include special education programs for drivers regarding careless driving. Further regulations should include fatigue driving, early detection of vehicle defects. Enforcement of police on highways and alerting the driver when exceeding law full speed as a countermeasure may reduce the heavy-duty single-vehicle crashes.

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## The risk and cost of pelvic and lower limb fractures from road transport crashes: Motorcyclists are key

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### Abstract

Pelvic and lower limb fractures from road transport crashes (RTCs) form a considerable proportion of the trauma related workload in acute care settings and is an area of focus, not only for the health care sector, but for road safety. Post-crash analysis of linked Queensland hospitalisation data was undertaken to calculate the risk and cost of acute treatment, in addition to the risk and cost of hospital readmissions 12 months post injury, by road user group (car occupants, motorcyclists and cyclists). Risk of hospitalisation was 26 times higher for motorcyclists than car occupants, with hospitalisation costs being \$80 per registered motorcycle, compared to \$4 per registered car. Over 24% of injured motorcyclists are readmitted within 12 months; this is 28% higher than car occupants. Data linkage is crucial for providing a more comprehensive profile of hospital utilisation and associated costs beyond initial acute treatment.

### Background

Pelvic and lower limb fractures from road transport crashes (RTCs) form a considerable proportion of the trauma-related workload in acute care settings (Vallmuur, 2017), and have been recognised by the Queensland Trauma Committee of the Royal Australasian College of Surgeons as an area of focus. Even though the road toll is declining (Department of Transport and Main Roads, 2019), the morbidity burden to the health care sector cannot be understated.

The capability exists within Queensland to link hospital admitted patient data across hospitals, and over time for the same individual. In the absence of a statewide, unique patient identifier, this is achieved by the Department of Health using statistical linkage techniques. Using linked data for analysis allows a more thorough understanding of the 'patient journey' through the hospital system. This study aims to use linked hospitalisation data to capture all readmissions for ongoing treatment, follow-up procedures and resultant complications for those with RTC-related pelvic and lower limb fractures, and to calculate the risk and cost of acute treatment, in addition to the risk and cost of hospital readmission 12 months post injury, in different road user groups.

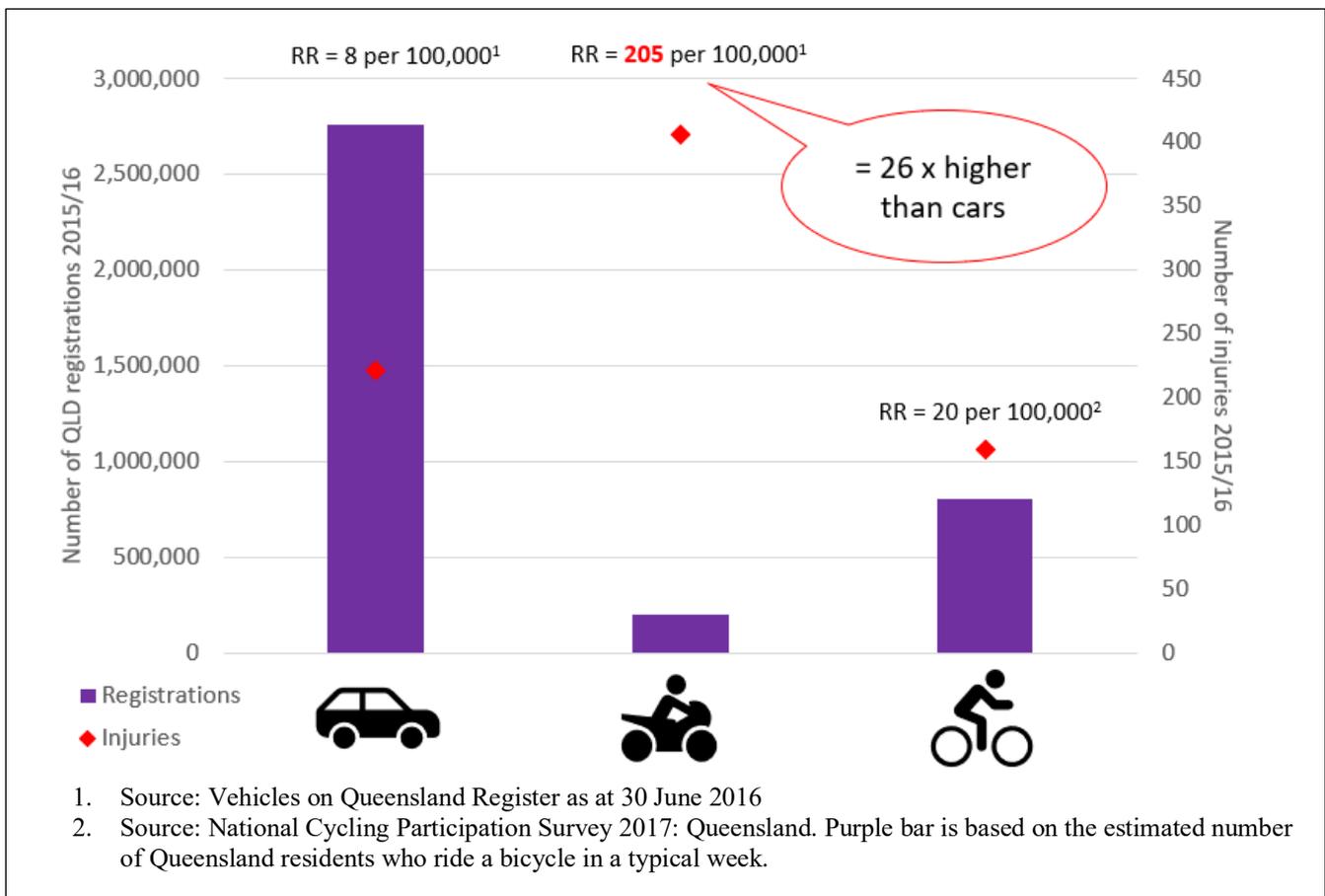
### Method

This is a retrospective cohort study using secondary analysis of routinely collected administrative data (Queensland Hospital Admitted Patients Data Collection - QHAPDC) linked to clinical costings. The QHAPDC holds data related to a patient's diagnosis and reason for admission, in addition to procedures undertaken within each episode of care provided in both public and private settings. However, clinical costings data are only available for episodes of care provided in public settings, hence private hospital costs are not included in this analysis.

Data for individuals admitted to Queensland hospitals between 1 July 2015 and 30 June 2016, following a RTC resulting in a pelvic or lower limb fracture were included. Hospital readmissions and associated costs data, for the 12 months following the index admission, were linked. The relative risk (RR) for initial injury and for hospital readmission was calculated, by road user group.

## Results

There were 924 pelvic and lower limb fractures from RTC's in Queensland in 2015/2016; 24% (n=222) were car occupants, 44% (n=406) were motorcyclists, and 17% (n=160) were cyclists. The relative risk (RR) of being injured on a motorcycle was 26 times higher than the risk of being injured in a car (Figure 1). In terms of acute public hospitalisation costs, the cost per motorcycle rider (\$80 per registered motorcycle) was 20 times higher than the cost per driver (\$4 per registered car). For bicycles, the cost was \$3 per cyclist. Over 24% of injured motorcyclists were readmitted to hospital within 12 months; this is 28% higher than for injured car occupants.



**Figure 1. Number of car, motorcycle and bicycle injuries relative to exposure (registrations/weekly bicycle usage)**

## Conclusions

This study has demonstrated that injury risk of motorcyclists is disproportionate to the number of registrations in Queensland. Using hospitalisation data on lower limb and pelvic fractures, a common injury sustained in RTCs, this study adds to knowledge from transport crash datasets by quantifying the risk of hospitalisation for acute inpatient treatment to be 26 times higher for motorcyclists than car occupants, with the cost of these hospitalisations being \$80 per registered motorcycle.

In addition, post-crash analysis using data linkage methods was able to provide a more comprehensive profile of hospital utilisation and associated costs. It is essential to understand the risk of hospital readmission following RTC-related injury, as further surgery and treatment of infections can occur following orthopaedic trauma. Ultimately, analyses of linked datasets provide important insights necessary for efficient resource planning by the health system, compulsory third-party insurers, policy-makers and transport regulators.

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## **Motorcycle Active Safety Systems: A cross-national comparison of applicability in the Australian, Italian, and US fleets**

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### **Abstract – 150 words**

Motorcycle-based active safety systems have great promise to mitigate crashes suffered by powered two-wheel (PTW) riders. Earlier studies have examined the applicability of these systems to individual crash types (i.e. rear-end vs intersection crashes) as a means of prioritizing active safety systems development. However, there may be large regional differences in crash type, motorcycle type and road systems: each of these regional differences may influence the applicability and the priority for development of motorcycles active safety systems. The study objective is to compare the applicability of five most promising active safety for motorcycles (Gil at al. 2017) in Italy and US using police-reported crash data from each region. Later, the results are compared with those obtained in a previous study (Savino at al. 2019) regarding the State of Victoria, Australia. The analysis found profound differences in the expected applicability of active safety systems across the three regions.

### **Background**

Previous research has estimated the applicability of five active systems as a function of crash mode in Australia (Savino et al, 2019). Unknown however is how these results will generalize to other regions of the world. Needed is a multi-region study to identify needs and opportunities for PTW active safety system development.

### **Method**

#### ***Data sources***

The study was based on PTW crash data from the Prato-X 2018 database in Italy and the Crash Reporting Sampling System (CRSS) 2016-2018 in the US. These data were compared with earlier results from analysis of the Road Crash Information System (RCIS) 2001-2011 in Victoria (Savino et al, 2019). The US data was restricted to crashes that occurred in urban areas for consistency with the Prato-X dataset which contained only urban crashes.

#### ***Accident categorisation and determination of the safety systems relevance***

To have the same codification between the three different databases, we recoded the crash types of the US and Italian data using the codification used in the Australian study, the VicRoads “Definition for Classifying Accidents (DCA)” (after first adjusting the codes for driving on the right side of the road). Recoding Prato-X, the DCA classification in only one event was considered not sufficient for some crashes (e.g. loss of control caused by emergency braking aimed at avoiding other crashes, or maneuvers where the type of impact is very different from that shown in the pictogram). Indeed, a second variable was used to better specify the cause and the manner of impact of those crashes. The applicability of the five safety systems in crashes was evaluated using the method in the original Australian study (Savino at al., 2019): scores from 1 to 4 awarded to DCA scenarios (Savino at al. 2019) were applied to Italian and American crash scenarios.

## Results

ABS was found applicable (category 4) to the highest number of crashes: 60.0% in Prato, 45.6% in US, compared to 40.6% in Australia. The difference between Prato and other countries is caused by the different composition of vehicle fleets. Likely, the low presence of ABS on vehicles involved in Prato's crashes (36% of vehicles are moped, low-cost vehicles never equipped with ABS) produces the high applicability of this system. As regards the safety systems useful in cornering, the maximum applicability in Prato was less than 5% while in US and Australia it is more than 10%. This Italian low applicability is likely influenced by the road system: due to narrow city roads and low speeds, crashes caused by loss of adherence in curves have almost never been detected in Prato-X. Reliable results were obtained for category 3 of the MAEB. The large difference between Prato and US is due to the greater number of side-banks crashes (they have a rating of 3 at the MAEB): in Prato they represent 10.2% of the total crashes, while in the US they are 2.9%. This different percentage reflects the different traffic conditions between the two countries: in Italy, it is normal for PTWs to pass between lines of stopped vehicles but is the main cause of crashes with lateral rubbing. In this way, we can see how a future development of the MAEB aimed to allow activation in the event that the opposite vehicle is front/side (for example, sideswipe) would have a great applicability,

## Conclusions

This study has shown that the applicability of production or anticipated PTW active safety systems, e.g., MAEB, is likely to be a strong function of the country into which these countermeasures are introduced. This has important implications for manufacturers seeking to prioritize the development for a particular PTW fleet. In addition, because active safety countermeasures may differ by motorcycle type, these regional differences suggest that regulators may need to consider country-specific minimum performance standards.

*Table 1. Applicability comparison between Italian and US crash database*

	CRSS- USA	Prato-X	CRSS- USA	Prato-X	CRSS- USA	Prato-X	CRSS- USA	Prato-X
	Category 1		Category 2		Category 3		Category 4	
<i>ABS</i>	15,8%	7,7%	28,0%	29,1%	10,6%	3,2%	45,6%	60,0%
<i>MAEB</i>	32,7%	33,0%	44,3%	28,1%	8,8%	31,2%	14,2%	7,7%
<i>CollWarn</i>	30,1%	31,2%	11,0%	7,0%	33,1%	29,8%	25,9%	31,9%
<i>CurvWarn</i>	84,2%	88,1%	5,7%	7,4%	0,0%	0,0%	10,1%	4,6%
<i>CurvAss</i>	70,4%	60,4%	11,4%	32,6%	7,9%	2,5%	10,4%	4,6%

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## **Floodwater on Roads: Driver behaviour and decision-making**

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### **Abstract**

In Australia, vehicle-related flood fatalities represent a large proportion of all flood deaths. Fitzgerald et al. (2010) and Hamilton et al. (2016) found that driving into floodwater accounts for 48.5% and 53%, respectively, of flood-related drowning deaths in Australia. However, little is known about the frequency and circumstances in which Australian drivers enter floodwater. Here we report the findings of a nationally representative survey (n=2104) that explores driver behaviour and decision-making around water on roads. We present a statistical analysis of drivers who have entered floodwater to identify the characteristics of drivers who are more likely to enter floodwater, and an analysis of the situational factors and influences on decision-making when drivers attempt to drive through floodwater. Lastly, we explore the implications of these findings for road safety, flood risk communication, and driver education.

### **Background**

Globally, floods are a significant cause of deaths during natural hazard events, and in Australia floods continue to present a significant risk to public safety (Haynes et al., 2017; Peden, Franklin, Leggat, & Aitken, 2017). Vehicle-related flood fatalities represent a significant proportion of all flood deaths in Australia; Fitzgerald, Du, Jamal, Clark, and Hou (2010) found that 48.5% of flood deaths in Australia between 1997 and 2008 involved a motor vehicle, and Hamilton K., Peden A.E., Keech J.J., and Hagger (2016) found that driving into floodwater accounts for 53% of flood-related drowning deaths in Australia. Analysis of fatality data provides useful insights, but less is known about how frequently Australian drivers enter floodwater, the circumstances under which drivers enter floodwater, what consequences they face, and the key influences on their decision-making.

### **Method**

This study aims to explore the behaviour and decision-making of the general public in Australia in relation to driving into floodwater, and to discuss the implications for road safety flood risk communication, and driver education. A public survey was distributed online and the sample was constructed to be proportionally representative of the adult Australian general population by jurisdiction, and balanced for age and gender. The survey included sections on demographics, willingness to drive through water on roads, experience of driving into floodwater or turning around, and risk propensity. Floodwater on the road was defined as an environment with:

- Water across the road surface;
- Little to no visibility of the road surface markings under the water (i.e. uncertainty of road quality/ integrity and possibly depth)
- Water on normally dry land, which could be either flowing or still.

### **Results**

In this paper we will present three main findings. Firstly, over half of the respondents (56%) had ever driven through or been driven through floodwater. Of those, 42% of respondents had driven/been driven through floodwater only once, and a further 41% had driven/been driven through on two or three occasions. This is indicative of the frequency with which Australian drivers enter floodwater. Secondly, survey responses were used to model who is more likely to drive through

floodwater if presented with the opportunity to do so. Two models will be presented that draw on 19 demographic and behavioural variables. Lastly, respondents (n=1167) provided detailed information about a specific instance where they drove through floodwater. We present an analysis of these responses to better understand the situational and environmental factors (e.g., water depth, flow) where Australian drivers are willing to enter floodwater as well as the consequences of driving through floodwater (e.g., none, rescue, car damage). We then examine the key personal, social and other influences on decision-making.

## Conclusions

This exploratory survey provides novel information about the experiences, behaviours, and decision-making of Australian drivers when floodwater is encountered. Understanding the frequency and types of situations where drivers enter floodwater, as well as the characteristics of drivers who are more likely to enter floodwater provides useful insights for agencies seeking to improve and target education and communications to improve driver and road safety.

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## Can walking and cycling for train access improve road safety?

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### Abstract

This paper investigates the impacts of train commuters' access modes on road safety at a network-wide level, using a case study in Victoria, Australia. Crash and census data were aggregated at the Statistical Area Level 1 (SA1) for the analysis. Results of negative binomial regression models illustrate positive effects of using train for commuting, either with walking or car access modes, on reducing both total crashes and severe crashes. The safety effects of commuting by train with the cycling access mode appear to be positive, which however were not statistically significant.

### Background

Previous research has shown that commuting by public transport, particularly train, would reduce the total crashes and severe crashes (Truong & Currie, 2019). However, to connect to public transport, particularly train, travellers need to use various types of access modes (e.g., walking, cycling, or driving), which have very different safety implications (TIC, 2018). Walking and cycling are usually promoted in place of car travel due to their health benefits, low cost, and low environmental impacts (Cervero, 2001; Cervero, Caldwell, & Cuellar, 2013). However, pedestrians and cyclists are also widely considered as vulnerable road users (Zegeer & Bushell, 2012). Yet, little research has been done to investigate how train access modes contribute to the overall safety, especially at a network-wide level. This paper aims to investigate the impacts of train commuters' access modes on road safety at a network-wide level using negative binomial regression. The state of Victoria, Australia is selected as a case study.

### Method

Census data in 2016 and road crash data from 2014 to 2018 were aggregated at the Statistical Area Level 1 (SA1). Two models were then developed for the total crashes and severe crashes, respectively, using negative binomial regression. Independent variables include journey to work mode shares (train with different access modes, tram, bus, walk, bicycle, motorcycle, and car), transport network (proportion of freeways and arterials, number of signalised intersections, train stations, bus and tram stops), sociodemographic characteristics (proportions of 0-14 age group and unemployment), and land use entropy. Population was used as the exposure variable. While traffic volume passing through SA1s was not considered in the analysis, transport network variables can act as its proxies. The proportions of train access by car (car driver and car passenger), cycling and walking were derived from the multi-modal journeys of train commuters. For simplicity, commuters who use bus or tram to access train are also considered train commuters with walking access.

### Results

Table 1 showed that a higher proportion of commuting by train with car or walking access was strongly associated with fewer total crashes and severe crashes. The coefficients of commuting by train with cycling access were negative, suggesting positive safety effects that were however not statistically significant. Positive safety effects of commuting by tram and bus were also evident. Overall, the increase in public transport usage might reduce the number of private cars on the roads and therefore associated crash risks. Commuting by walking or motorcycling would increase both total crashes and severe crashes. Bicycle commuting would also increase total crashes. Results also confirmed the expected effects of sociodemographic and transport network variables.

**Table 1. Results of negative binomial regression for total crashes and severe crashes**

Variables	Total crashes		Severe crashes	
	Estimated	SE	Estimated	SE
Intercept	-0.433	0.117 ***	-1.071	0.145 ***
Log of population	0.076	0.02 ***	0.06	0.025 *
Proportion of 0-14 age group	-1.655	0.184 ***	-2.208	0.242 ***
Proportion of unemployment	-0.702	0.229 **	-1.89	0.303 ***
Land use mix - entropy	0.036	0.026	-0.133	0.034 ***
Proportion of freeway and arterial network	1.854	0.045 ***	1.668	0.057 ***
Number of signalized intersections	0.261	0.012 ***	0.175	0.014 ***
Number of train stations	0.193	0.058 ***	0.232	0.071 **
Number of bus stops	0.133	0.003 ***	0.13	0.004 ***
Number of tram stations	0.102	0.018 ***	0.108	0.022 ***
Proportion of commuting by train with car access	-5.529	0.54 ***	-6.561	0.729 ***
Proportion of commuting by train with walking access	-1.547	0.126 ***	-2.303	0.168 ***
Proportion of commuting by train with cycling access	-1.416	3.459	-2.357	4.684
Proportion of commuting by bus	-2.62	0.382 ***	-3.466	0.506 ***
Proportion of commuting by tram	-1.99	0.235 ***	-2.924	0.306 ***
Proportion of commuting by walking	3.008	0.158 ***	3.239	0.191 ***
Proportion of commuting by cycling	0.87	0.434 *	-0.514	0.577
Proportion of commuting by motorbike	7.705	1.068 ***	9.134	1.316 ***
Dispersion parameter ( $\theta$ )	1.13	0.02 ***	0.91	0.02 ***
Log-likelihood		-31,944		-19,719
AIC		63,925		39,476
Sample size		13,768		13,768

Note: \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ ; SE = Standard error; AIC = Akaike information criterion

## Conclusion

In summary, mode shift from private vehicle to train for commuting, either with walking or car access modes, would significantly reduce both total crashes and severe crashes at a network-wide level. While cyclists are vulnerable road users, there is no evidence of negative safety impacts of cycling as a train access mode. An important implication of this study is that promoting walking for public transport access, particularly train, would create a synergistic effect on public health, road safety, the environment, and economy. Future research should enhance the modelling approach by explicitly considering traffic passing through an area or vehicle distance travelled.

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## Agreement on fitness to drive outcome between Rehabilitation Medicine Physician prediction and Occupational Therapy on-road assessment

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### Abstract

Assessment of fitness to drive is a complex and ideally multidisciplinary process, with no defined gold standard of assessment. This prospective audit investigates the agreement on fitness to drive outcome between Rehabilitation Medicine Physician (RMP) prediction and occupational therapy (OT) on-road assessment results in 242 patients across a 4 year period. Prediction is based on history, collateral history, screening assessments and clinical judgement of a doctor experienced in driving assessment. Objective practical on-road assessments are completed by a driver-trained occupational therapist. Correlation is further assessed for subcategories of cognition and assessment for vehicle modification. The percentage of agreement was 88.6% with slight agreement (weighted kappa 0.25) between the RMP and OT on-road outcome. The percentage of agreement was greatest (91.4; weighted kappa 0.3) for patients that required modification assessment, and lowest (85.7%, weighted kappa 0.24) for patients undergoing assessment for cognitive indications. This study demonstrates higher level of correlation for clients undergoing assessment for physical limitations, with prediction of impact of cognition on driving performance evidenced as more challenging. Occupational therapy on-road assessment is therefore a pivotal assessment tool to ensure maximization of both maintenance of client independence, and identification of at-risk clients.

### Background

In Australia, medical practitioners are the first-line health professionals responsible to assess fitness to drive individuals with medical conditions that could impact their driving capabilities, with reference to the Austroad guidelines (Assessing Fitness to Drive, 2016). Rehabilitation Medicine Physicians are one of the medical specialties with expertise in assessing and screening individuals with medical conditions for fitness to drive. No individual off-road screening assessment is reliably predictive of on-road performance, with evidence recommending a battery of assessments to assist in evaluation. Referral to occupational therapy on-road assessment is recommended when further evaluation is required, to both supplement and inform clinical assessment (Assessing Fitness to Drive, 2016). Two studies have reported moderate to high agreement between referring physicians and the on-road assessors in multiple sclerosis (Ranchet, Akinwuntan, Tant, Neal & Devos, 2015) and in stroke (Ranchet et al., 2016). Another study in a dementia population showed a low agreement between physicians and on-road assessors (Ranchet, Tant, Akinwuntan, Morgan & Devos, 2016). Therefore, this study is to investigate the agreement on fitness to drive between Rehabilitation Medicine Physician (RMP) prediction and occupational therapy (OT) on-road results in a mixed population, with sub-analysis to investigate correlation differences when cognitive domains are the main indication for practical assessment.

### Methods

Data were retrieved from a prospectively collected clinic database from date range between 2015-2018. The Driving Fitness Assessment Clinic is a multidisciplinary clinic based at Flinders Medical Centre, South Australia. Data prospectively collected included demographic data, nursing assessments, and referrals / outcomes. Demographics included date of birth, gender, reason for referral, referral sources, and driving status at referral. Screening assessments completed by nurses

included visual acuity assessment using a standardised six (6) metre Snellen Chart, a Mini Mental State Examination, a Trail Making A & B test and a Freund Clock Drawing test. Medical assessments (Rehabilitation Medicine physician or Registrar) included thorough medical and driving history, and physical and visual fields assessment using confrontation testing. Driving standards were assessed against the Austroad guidelines (Assessing Fitness to Drive, 2016). For clients referred to OT assessment, the database included physician prediction of outcome prior to OT on-road assessment. The assessing OT did not have access to the consultant prediction. Once the OT on-road assessment was carried out using a standardised route, the results were compared to the physician prediction. Both consultant prediction and OT outcome were categorised into four outcome categories: pass without conditions, pass with conditions, pass with modifications and recommendation of suspension.

Inclusion criteria includes patient aged 18 and above referred to Flinders Medical Centre Driving assessment clinic, assessed by a Rehabilitation Medicine physician for Occupational Therapy on-road assessment, and prediction of outcome recorded. Only clients who had consented to having details recorded in the prospective database were able to be included.

Correlation of agreement between RMP prediction and outcome of OT driving assessment were analysed using Stata Statistical Software: Release 16.0.

## Results

A total of 1258 patients were referred to Flinders Medical Centre, South Australia Driving Assessment Clinic between 2015 and 2018. 636 (50.5%) were referred for an OT assessment- 274 patients with recorded physician prediction plus an OT on-road referral. Of these 274, a total of 242 patients completed OT assessment and were therefore included for analysis.

For the 242 analysed cases, the mean age was 67.6 ( $SD=16.7$ ) and 70.2% were male (Table 1). Casemix included stroke, cognition / dementia, acquired brain injury, other neurological (for example, multiple sclerosis, Parkinson's disease), amputee and orthopaedic presentations. Cognition / dementia represented the greatest percentage of referrals (36.4%) (Table 1).

Table 1: Demographics and referral reason of analysed cohort (n=242)

	Total (n=242)
Age (years)	67.6 (16.7)
Male, n (%)	170 (70.2%)
Reason for referral, n( %):	
Cognition / dementia	88 (36.4%)
Stroke	60 (24.8%)
Other neurological	46 (19.0%)
Acquired brain injury	16 (6.6%)
Other medical reason	15 (6.2%)
Amputation	9 (3.7%)
Orthopaedic	4 (1.7%)
Combined reason	4 (1.7%)

The main reasons for referral for OT assessment included cognition (53.3%), modifications (22.7%), vision (6.2%), or combined factors (10.3%). Smaller numbers were recorded for indications of inattention (0.4%), fatigue (2.5%) or other (4.5%).

The percentage of agreement between physician and OT on-road outcome for the full sample was 88.6%, correlating with a fair degree of agreement precision (weighted kappa 0.25). Agreement precision of the physician prediction and OT on-road outcome showed considerable differences

between the subcategories of cognition and assessment for modifications. Corroboration was highest for in relation to patients requiring assessment for vehicle modifications (n= 62) with 91.4% agreement. For the cognitive cohort (n= 150), only 85.7%% agreement was noted, aligning with a ‘fair’ degree of agreement precision.

Table 2. Agreement between physician prediction and OT-road assessment outcome for total sample (n=242)

Rehabilitation Medicine Physician prediction	OT on-road assessment outcome				Total
	Pass	Pass with Conditions	Pass with Modifications	Fail	
Pass	3	19	2	0	24
Pass with Conditions	17	105	14	24	160
Pass with Modifications	0	13	12	0	25
Fail	0	20	1	12	33
<b>Total</b>	20	157	29	36	242
<b>Percentage Agreement</b>	<b>Expected Agreement</b>	<b>Kappa</b>	<b>SD</b>		
88.6%	84.9%	0.25	0.06		

## Conclusions

This study demonstrates a fair overall agreement between Rehabilitation Medicine Physician prediction and OT on-road outcome. Agreement precision is strongest when predicting outcomes for modification assessment. The more challenging prediction is noted for client’s with cognitive impairment, as well as in detailing appropriate outcome details beyond simple binary pass/fail. These findings add weight to the use of OT on-road assessment as the gold standard for assessment. The combination of medical and OT practical assessment allows an individualised assessment approach and maximises outcomes focussed on independence and safety.

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## Snap-chat – Mobile phone camera enforcement and community attitudes

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### Abstract

The introduction of mobile phone detection cameras in NSW is a world-first program to target phone use while driving, a critical aspect of distracted driving. Monitoring community attitudes to this new enforcement is important, as insights gained can be used to adapt and develop policy. The study reported here, when completed, will provide a series of snap shots of community views over the period of the introduction and deployment of mobile phone cameras. Early indications from the data show that there is strong community support for the new enforcement program, with a shift in drivers' perceptions towards an increased likelihood of being caught for a mobile phone offence. There is concern that the demerit point penalty for the offence is too harsh, although the fine penalty is accepted. It is anticipated that the mobile phone camera enforcement program will result in a positive change in driver behaviour.

### Background

Mobile phone detection cameras have been introduced in NSW to target illegal phone use, operating in both fixed and transportable trailer-mounted modes (Transport for NSW, 2019). Following a successful trial in early 2019, legislation to permit camera-based enforcement was introduced (Faulks, 2019). This legislation is being debated in the NSW Legislative Council currently (NSW Parliament, 2019).

It is a relatively unusual situation for a completely novel traffic enforcement program to be introduced, and as the impact of the new enforcement on driver behaviour is expected to be considerable, a research project to monitor community attitudes was instigated.

### Method

A convenience sample is being obtained from offenders attending the Blacktown Traffic offenders Program (Faulks, Siskind & Sheehan, 2019). Offenders may complete a survey about driving, mobile phones and the new camera enforcement program, as part of a weekly assignment task. A target of 200+ survey responses is planned by mid-2020; by February 2020 about a quarter of these survey responses have been received.

### Results and Discussion

Some preliminary findings are presented below, categorised as younger drivers (16-29 years) or older drivers (30+ years).

When asked about their driving behaviour during a typical week, respondents indicated that:

- Both older and younger drivers were unlikely to hold a phone when driving;
- About half of both older and younger drivers said they used a hands-free phone while driving (despite novice drivers being banned from using any mobile phone function when driving);
- Both older and younger drivers used the GPS / map functionality on a mobile phone (again, this is prohibited for novice drivers in NSW); and,

- Younger drivers were more likely to use other apps on their mobile phone.

More generally,

- One third of older drivers and half of the younger drivers admitted that they would drive at more than 10 km/h over the speed limit during a typical week;
- Young drivers were very unlikely to drive after drinking three or more standard drinks, but some older drivers reported that they did so; and
- About half of the older drivers reported that they drove when fatigued.

Respondents thought the fine for a mobile phone offence (A\$344, or A\$457 if in a school zone) was appropriate, but that 5 demerit points for a mobile phone offence was harsh.

Prior to the introduction of camera-based enforcement respondents thought it very unlikely that they would be caught for a mobile phone offence when driving. There was some indication that this view was shifting, with a perceived increased chance of being detected by both fixed and transportable mobile phone enforcement cameras.

Generally, respondents would accept and pay a fine if camera-detected for mobile phone use while driving. Some older drivers (aged 30+ years) indicated they would seek a Court appearance to challenge or plead in mitigation. Overwhelmingly, respondents thought that a photo of the offence should be included in the fine notice.

Support for the use of warning signs about speed cameras in NSW was generally very high; however, while older drivers thought similar signage should be used for mobile phone camera enforcement, younger drivers did not support such signage being used.

### **Concluding comment**

Overall, it seems that community attitudes to the introduction of mobile phone camera enforcement are positive, and the enforcement program may well see a change in driver behaviour.

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## Modelling the relationship between driver history and crash risk

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### Abstract

The objective of this study was to determine if offence history can be used to predict future Fatal and Serious Injury (FSI) crash involvement. Using data extracted from Victoria's Road Crash Information System and Driver Licensing System, statistical models for future FSI crash involvement were developed using machine learning methods. Models were produced for a general sample (representative of the general population) and five subgroups (probationary, older, heavy vehicle, motorcycle and banned drivers). The accuracy of models improved when offence history variables were included with demographic and licensing variables. Speeding, seatbelt and traffic light offences and driving bans were important predictors for future FSI crash involvement in the general sample. Total number of recent offences and traffic infringement notices (TINs) were important predictors for future FSI crash involvement for the subgroups.

### Background

The effect of transport policy changes on road user safety is often measured by involvement in fatal and serious injury (FSI) crashes. With this measure the time taken to collect enough data to make decisions may be inappropriate. Research linking offence history to FSI crash involvement (Factor, 2014; Cooper, 1997; Kumfer, Wei & Liu, 2015; Wundersitz & Burns, 2004) suggests offence history may provide a more temporally efficient measure of crash risk. This study aimed to determine if offence history can improve predictions of future FSI crash involvement, when modern machine learning techniques and specialised statistical methods are used for model selection.

### Method

Drivers in FSI crashes between July 2015 and June 2018 were identified in the Road Crash Information System (N=22,641). Licensing and offence history were extracted from the Driver Licensing System between July 2013 and June 2015 for all of these drivers, and a 1% random but demographically matched sample of non-crash involved drivers (N=57,742). An exploratory analysis identified five important driver subgroups. After removing drivers unlikely to be involved in crashes due to age or licensing status, the sample size reduced to N=63,228. Machine learning methods were then used to select variables for developing logistic regression models to predict future FSI crash involvement, for the general sample and each subgroup. In addition, an offence history cluster analysis was conducted for the general sample, identifying six segments with differing future FSI crash involvement risk.

### Results

Table 1 compares the FSI crash involvement rates for the general sample and the five subgroups. On average, the odds of FSI crash involvement were 97% higher for probationary drivers, 67% higher for heavy vehicle drivers, 105% higher for motorcyclists and 246% higher for banned drivers than for the general sample. However, these odds were 31% lower for older (60-90 year) drivers than for the general sample. As shown in Table 1, only small increases in the Areas Under the Receiver Operating Curve (AUR) occur when offence history is added to models based only on demographics and licensing history, suggesting little improvement in model accuracy. However, this improvement is significant ( $p < .05$ ) for all but the banned subgroup, although overall model accuracy is low

(AUR<70%). In Table 1 adjusted odds ratios are provided for significant ( $p<.05$ ) offence history predictors of FSI crash involvement, with values above one for increased odds and values below one for reduced odds of future FSI crash involvement.

**Table 1. Logistic regression results for future FSI crash involvement: Offence history predictor variables controlling demographic and licensing variables by subgroup**

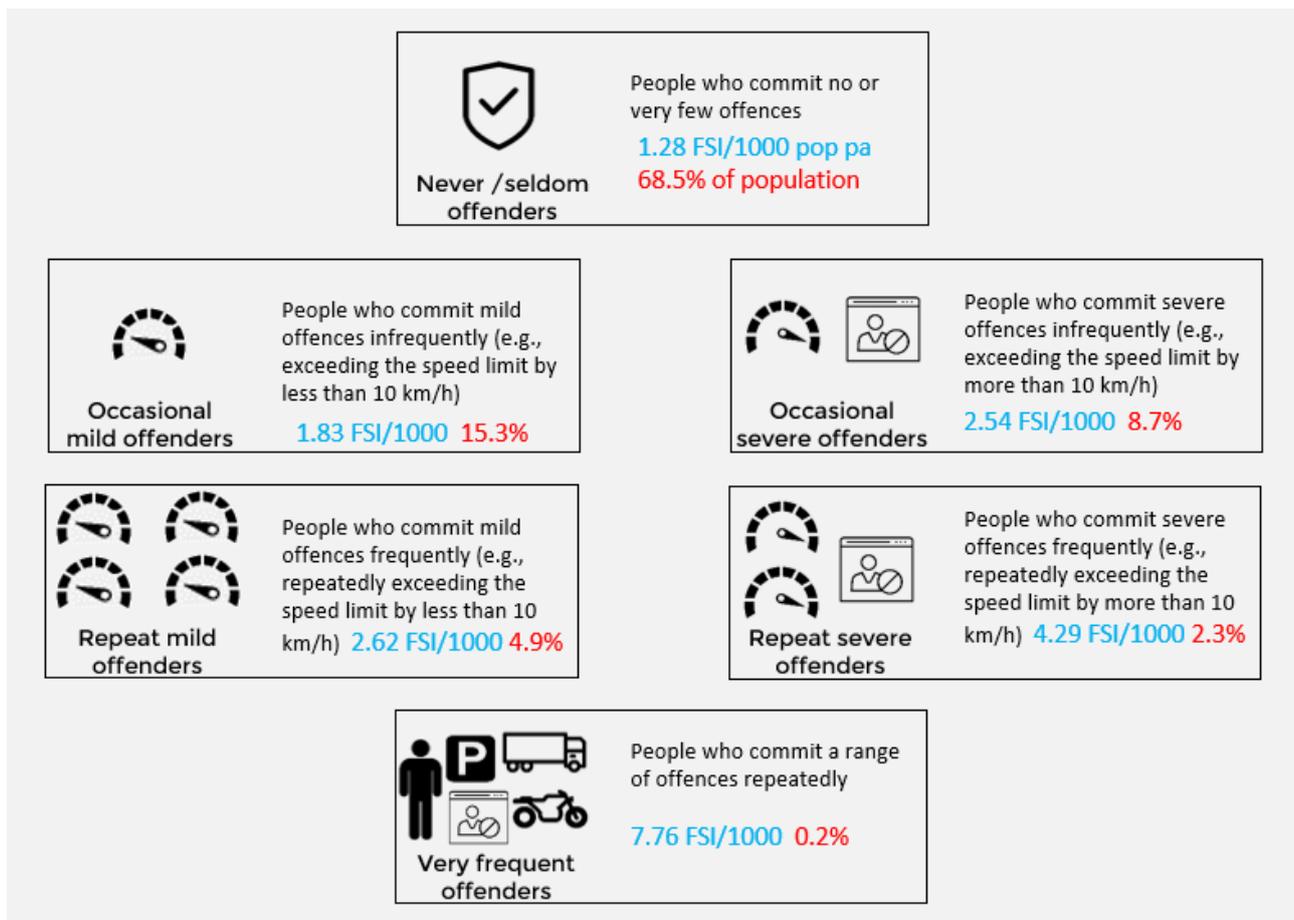
	General (N=63,238)	Prob- ationary (N=5708)	Older (N=13,578)	Heavy vehicle (N=8775)	Motor-cycle (N=7783)	Banned (N=1536)
<b>FSI rate/1000 pop pa</b>	1.62	2.98	1.21	2.51	3.00	5.36
<b>Overall odds ratio</b>	1.00	1.97	0.69	1.67	2.05	3.46
<b>AUR without offence history</b>	.640	.592	.610	.642	.586	.601
<b>AUR with offence history</b>	.664	.622	.641	.659	.627	.620
<b>Adjusted Odds Ratios (95% confidence intervals)</b>						
<b>No. of high excess speed (<math>\geq 10</math> km/h) offences</b>	1.15 (1.09, 1.21)					
<b>No. of failure to wear seatbelt offences</b>	1.24 (1.02, 1.50)					
<b>No. of disobey traffic light offences</b>	1.14 (1.07, 1.22)					
<b>No. of other road use offences<sup>†</sup></b>	1.37 (1.26, 1.49)		1.73 (1.29, 2.33)		1.38 (1.13, 1.69)	1.21 (1.08, 1.37)
<b>No. of offences</b>		1.12 (1.08, 1.16)	1.26 (1.21, 1.32)	1.18 (1.14, 1.23)		
<b>No. of traffic infringement notices</b>	1.11 (1.05, 1.16)				1.16 (1.11, 1.21)	
<b>No. of bans</b>				1.35 (1.05, 1.75)		
<b>No. of suspension bans</b>					2.39 (1.61, 3.56)	1.28 (1.09, 1.51)
<b>Max. ban duration</b>						
<b>No bans</b>	1.00					
<b>Less than 3 months</b>	1.56 (1.26, 1.93)					
<b>Between 3-6 months</b>	1.56 (1.02, 2.39)					
<b>More than 6 months</b>	1.48 (1.17, 1.87)					

Note: grey cells indicate the predictor variable was not a statistically significant predictor of FSI crash involvement for that sample; cells = 1.00 indicate that this category is the reference group for the indent categories below it. <sup>†</sup> "other" road use offences included a variety of offences including careless driving, no head- or tail-lights and unsafe reversing. AUR=measure of model accuracy with values closer to one preferred. For "No. Of Offence" variables the adjusted odds ratio provides the increase or decrease in the odds of FSI crash involvement for each additional offence, while controlling for all the other variables in the model (e.g. a 20% increase in the odds of FSI crash involvement for each additional offence if the odds ratio equals 1.20).

Cluster analysis (Figure 1) confirmed the above results, with the rate of FSI crash involvement increasing from 1.28 to 7.76 per 1000 drivers per annum with increasing levels of offending.

## Conclusions

This study shows offence history significantly improves predictions of FSI crash involvement based on demographics and licensing history. Low model accuracy prevents using them for predicting FSI crash involvement risk for individual drivers. However, these models are helpful in identifying driver groups to target with further interventions.



**Figure 1. Driving Offence Clusters with FSI Crash Rates and Population Representation**

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## Does Biomechanical and Epidemiological Evidence of Bicycle Helmet Effectiveness Translate to a Population?

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### Abstract

Many studies have found bicycle helmets reduce the risk of head injury following a crash or fall. Some argue these do not translate to a population reduction in cycling head injury. This is often due to a lack of relevant data prior to helmet promotion and/or legislation. Western Australia introduced bicycle helmet legislation on January 1992 and, unlike other Australian states, has electronic hospital records from the early 1970's. Using an interrupted time series approach, the rate of serious head injury per 100,000 were compared following helmet promotion from the mid-1980's and helmet legislation in 1992. Serious head injury among cyclists were increasing prior to helmet promotion or legislation but reduced by a combined 63% by 1993. This reduction coincided with large increases in helmet wearing in WA across all-ages.

### Background

Bicycle helmet use has been shown to be effective at mitigating the risk of head injury in a crash in numerous biomechanical and epidemiological studies (McIntosh, Lai & Schilter, 2013; Stigson, Rizzi, Ydenius, Engström & Kullgren, 2017; Olivier & Creighton, 2017; Høye, 2018). However, some authors argue these studies do not translate to a population-level effect (Robinson, 2006). Past research has been limited by little data on helmet wearing or a long time series of injury data prior to the uptake of bike helmets. A notable exception is Western Australia (WA) who promoted bicycle helmets from the mid-1980s and introduced bicycle helmet legislation in January 1992. The aim of this study is to assess whether changes in bicycle helmet wearing are associated with declines in bicycle-related serious head injuries in WA.

### Methods

Bicycle helmet wearing data was extracted from WA reports (Healy & Maisey, 1992; Heathcote, 1993), which include estimates by direct observation for primary and secondary school children, commuter and recreational cyclists for years 1986-1993. Bicycle hospitalization data was provided by the WA Department of Health for years 1971-2013. WA hospitalization data has been coded using International Classification of Diseases (ICD) version 8 (1971-1978), version 9 (1979-1987), version 9-CM (1988-June 1999), and version 10 (since July 1999). Serious head injuries were identified as a skull fracture (N800-N804, 800-804, S02), intracranial injury (N850-N854, 850-854, S06), or open head wound (N870-N873, 870-873, S01). Midyear population estimates for WA were downloaded from the Australian Bureau of Statistics website.

An interrupted time series approach was used to assess changes in serious bicycle-related head injury for three distinct time periods: pre-helmet promotion or legislation (1971-1986), helmet promotion (1987-1991), and post-helmet legislation (1992-2013). A segmented Poisson regression model for the mean number of serious head injuries  $\mu_t$  at time  $t$  (years since 1971) was:

$$\log \mu_t = \beta_0 + \beta_1 t + \beta_2 x_{1t} + \beta_3 x_{2t} + \beta_4 t x_{1t} + \beta_5 t x_{2t} + \log N_t$$

where  $x_{1t}$  and  $x_{2t}$  are indicator functions for the helmet promotion and post-legislation periods respectively, and  $N_t$  is the WA population at time  $t$ . Relative to the existing trend, the impact of

helmet promotion is  $\exp(\beta_2 + 15\beta_4) - 1$  and the impact of legislation is  $\exp(\beta_3 + 21\beta_5) - 1$ . An autoregressive error process of lag one was included to account for serial correlation. This study was approved by the Human Research Ethics Committee of the WA Department of Health (2014/44).

## Results

Estimates of helmet wearing for primary school and commuter cyclists increased steadily from 22% and 19% respectively in 1987 to 87% and 96% respectively in 1993. Helmet wearing increased more abruptly for high school students and recreational cyclists with an estimated 66% and 79% respectively wearing helmets in 1993.

Prior to helmet promotion or legislation, the rate of serious head injuries per 100,000 population increased by 2.2% per year (95% CI: -0.03%, 4.5%). Immediately after helmet promotion began, the rate decreased by 15.8% (95% CI: -38.0%, 14.4%) and by 62.7% (95% CI: -73.9%, -46.7%) after helmet legislation. The results are consistent with estimates of helmet effectiveness for serious head injury (Olivier & Creighton, 2017; Høye, 2018) and are similar to the reduction in WA cycling fatalities at that time (Olivier, Boufous & Grzebieta, 2019).

## Conclusions

Bicycle helmet use in WA was not common until the mid-1980s and increased to around 80% in 1993 after years of helmet promotion and the introduction of a bicycle helmet law. The trend in serious head injuries for cyclists steadily increased prior to helmet promotion, and then rapidly declined and levelled off. Although it could be argued any reduction in bicycle injuries were due to deterrent effects of bicycle helmet legislation, this hypothesis is inconsistent with trends in cyclists injured solely below the neck (not shown) and estimated frequencies of cycling in WA from stratified random sampling surveys from before to after helmet legislation (Olivier, Boufous & Grzebieta, 2016).

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## **Supervised practice hours among older novice drivers in Victoria: Stakeholder perceptions and readiness to obtain supervised driving practice**

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### **Abstract**

There is no requirement in Victoria for learner drivers older than 21 years to complete supervised driving practice before sitting the drive test. This research sought to understand stakeholders' views about the value of supervised driving experience for learners over 21 and the willingness of older novice drivers' to complete supervised practice hours. Focus groups and interviews with novice drivers, licence testing officers, and driving instructors (Study 1) showed agreement that supervised driving experience for older novices may result in better, safer drivers. An online survey with older novice drivers (N = 968) (Study 2) revealed approximately one third had completed at least 80 hours of supervised practice; the remainder reported they would be willing to complete 72.25 hours (SD = 33.60) before sitting the drive test. Improving access to supervisors could help to increase the number of practice hours that older novice drivers in Victoria complete.

### **Purpose**

This research was part of two larger projects that explored i) stakeholder perspectives of whether the drive test tests drivers' competency for solo driving, and ii) which types of initiatives could encourage older novice drivers to complete more supervised practice hours before sitting the drive test.

The objective of Study 1 was to identify internal and external stakeholders' qualitative views about the on- road drive test, including: i) the requirement for 120 hours of supervised driving experience and its impact on readiness to drive solo; ii) supervised driving experience for learners aged 21 to 25 years; and iii) resources available for learners and pre-learners to assist them to prepare for the drive test.

The objective of Study 2 was to gain a broad understanding of: i) the total number of supervised practice hours that older novice drivers in Victoria complete; ii) the total number of hours they would be willing to complete; and iii) what influences the number of supervised practice hours they complete.

### **Methodology**

In Study 1, six focus groups were conducted (in Melbourne and Bendigo) with a range of young novice drivers aged up to 29 years old. In addition, six in depth interviews of 30-45 minutes in duration were conducted with drivers aged 18-30 years who were required to undertake the on-road drive test to convert an overseas licence to a Victorian driver licence.

Consultation took place with driving instructors and VicRoads staff from customer service, training, investigations, Operational and Licensing Policy, and with licensed testing officers (LTOs).

In Study 2, an online survey was conducted with novice drivers aged 21–30 years (N = 968) who were living in Victoria and had not previously sat and passed the drive test in Victoria.

### **Key findings**

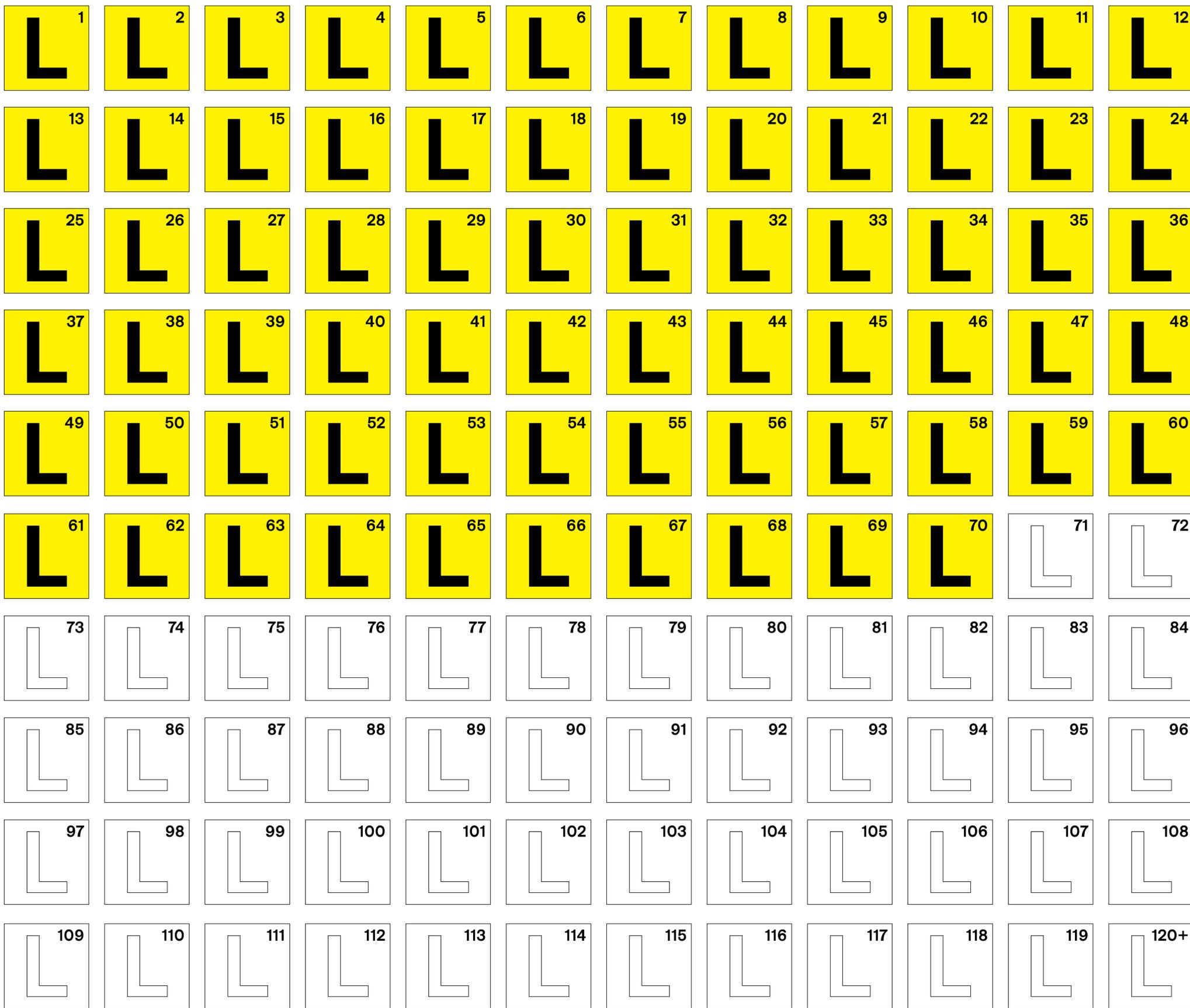
Participant sentiment indicated there was strong, consistent support for 120 hours for 18–21 year-old learner drivers and general agreement hours of supervised driving experience for older novices may result in better, safer drivers. However, participants raised that consideration should be given to

greater maturity and lower risk-taking behaviour among older novice drivers, and also access to a supervising driver.

Of the eligible older novice drivers who completed Study 2 ( $N = 968$ ), 32.23% reported that they had already completed at least 80 hours of supervised driving practice. Of those who had not yet completed 80 hours ( $N = 656$ ), the mean total number of supervised driving practice hours completed was 26.50 hours ( $SD = 21.69$ ) and the mean number of hours they reported they were willing to do was 72.25 hours ( $SD = 33.60$ ).

Our findings across both studies revealed that difficulties with accessing a vehicle or a supervisor (including paid instructors) and the financial costs of professional driving lessons were commonly experienced barriers for older novice drivers.

Finding which types of initiatives could reduce these barriers or could encourage older novice drivers to complete more supervised practice hours voluntarily would be valuable.



# SUPERVISED PRACTICE HOURS AMONG OLDER NOVICE DRIVERS IN VICTORIA:

## STAKEHOLDER PERCEPTIONS AND READINESS TO OBTAIN SUPERVISED DRIVING PRACTICE

There is no requirement in Victoria for learner drivers older than 21 years to complete a mandated number of supervised driving practice hours before sitting the drive test. This research sought to understand stakeholders' views about the value of supervised driving experience for learners over 21 and the willingness of older novice drivers to complete supervised practice hours.

This research was part of two larger projects that explored:

- i. stakeholder perspectives on whether the drive test tests drivers' competency for solo driving; and
- ii. which types of initiatives could encourage older novice drivers to complete more supervised practice hours before sitting the drive test.

We undertook focus groups and interviews with novice drivers, licence testing officers, and driving instructors; and we also undertook an online survey with older novice drivers.

The three key learnings were:

- 1** General agreement among stakeholders that hours of supervised driving experience for older novices may result in better, safer drivers.
- 2** Over one third (37.34%) of the eligible novice drivers who completed the online survey reported having already completed at least 80 hours of supervised driving practice. The remainder reported a willingness to complete 72.25 practice hours, on average.
- 3** Findings across both studies revealed that difficulties with accessing a vehicle or a supervisor (including paid instructors) and the financial costs of professional driving lessons were commonly experienced barriers for older novice drivers.

## Making nighttime pedestrians safer using innovative clothing designs

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### Abstract

Nighttime pedestrians are at significant risk of being killed or seriously injured, because drivers often fail to see them in time to avoid a collision. Clothing incorporating retroreflective markers on the moveable joints creates a visual perception of ‘biomotion’ and improves nighttime pedestrian conspicuity. This study investigated whether biomotion-enhanced clothing retains its conspicuity if adapted to make it more acceptable to wear. In a nighttime closed road study, we compared the relative conspicuity of pedestrians to young drivers with normal vision when pedestrians wore biomotion strips of different thicknesses and patterns versus other typical clothing worn by nighttime pedestrians. Results showed that all the biomotion clothing resulted in significantly longer conspicuity distances than sports, fluorescent yellow or black clothing (4x longer distances than black clothing). These effects were evident regardless of pedestrian orientation and have implications for the design of clothing for walkers and runners to enhance their nighttime safety.

### Background

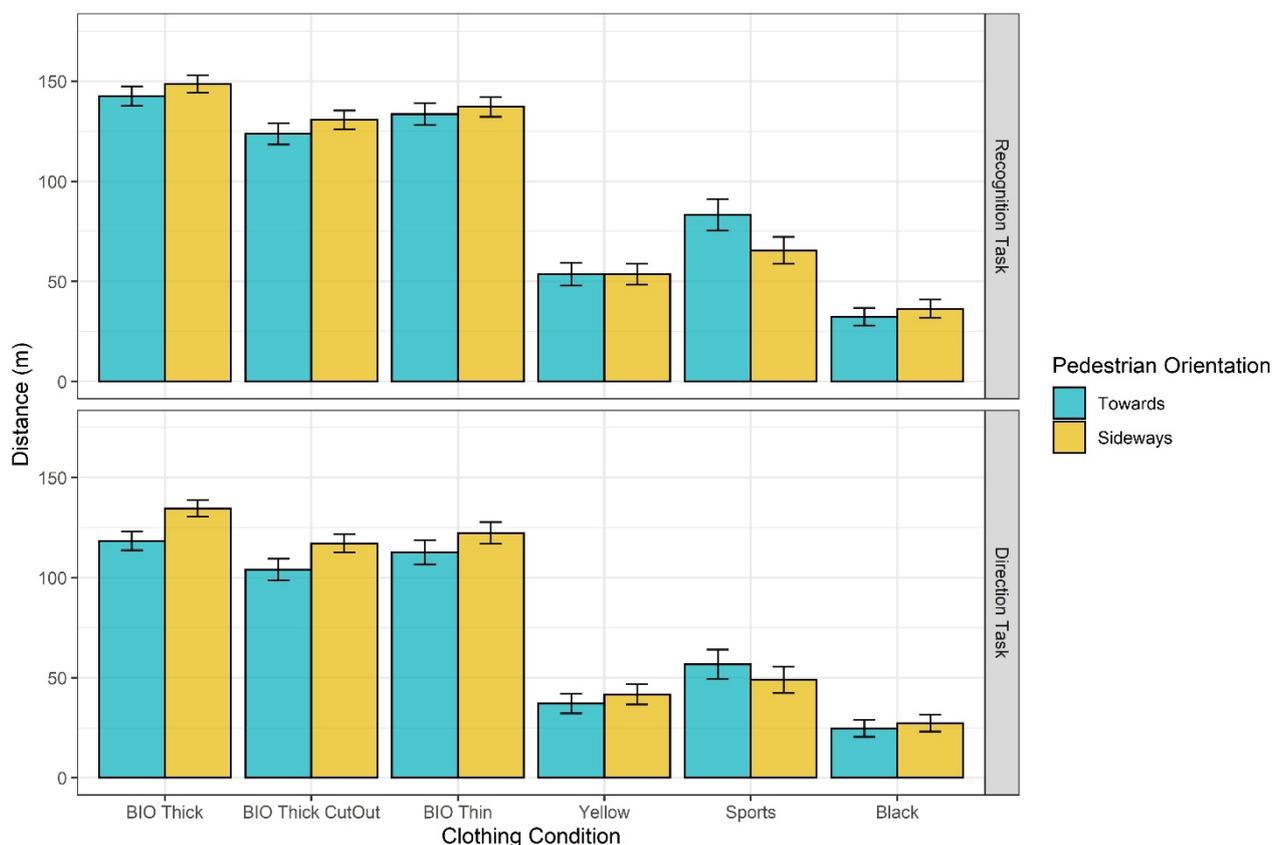
Fatality rates for pedestrians are up to seven times higher at night than in the day (Sullivan & Flannagan, 2007). While there are many contributing factors, reduced visibility is the most important, where drivers commonly fail to see pedestrians in time to avoid a collision. Research has demonstrated that clothing incorporating retroreflective material on the moveable joints (wrists, elbows, ankles, knees) improves nighttime pedestrian conspicuity by creating the perception of ‘biomotion’ for drivers (Wood, 2020). Importantly, most nighttime pedestrian studies have incorporated retroreflective strips in roadworker-type outfits, which are less appealing to wear for recreational pedestrians and runners. We explored whether biomotion clothing could be made more appealing, by reducing the width of the retroreflective strips, while still retaining high conspicuity.

### Method

Nighttime pedestrian recognition was measured for 14 visually normal, young participants (mean age (SD) = 24.3 (3.1) years), while they drove an instrumented vehicle around a closed-road circuit. Two pedestrians walked in place at the roadside at different locations, for two different orientations: facing towards, or sideways to the oncoming vehicle. For each lap, pedestrians wore one of six clothing conditions: three biomotion configurations with retroreflective strips 0.75cm wide (thin solid), 1.5 cm wide (thick solid) or 1.5 cm shaped (thick cut-out), as well as conditions with black leggings with either a black top (black), or a fluorescent yellow top, and one commercially-available nighttime sports outfit containing retroreflective material; the order of clothing condition was randomised. Drivers tapped a response pad when they first recognised a pedestrian was present (detection task) and a second time when they identified their walking direction (direction task: towards or sideways). To account for the repeated measures design, pedestrian recognition and direction detection distances were analysed separately with linear mixed models.

## Results

Overall, distances for the pedestrian recognition task were longer than for the detection of direction task ( $p < 0.001$ ). For the recognition task, clothing had a significant effect on recognition distances ( $p < 0.001$ ), where all the biomotion clothing resulted in significantly longer distances than sports, yellow or black clothing (Figure 1). Overall, pedestrians wearing biomotion strips were recognised earlier, at four times longer distances compared to when wearing black. There was no significant effect of pedestrian orientation on recognition distance ( $p = 0.84$ ), but there was a significant interaction of clothing and orientation ( $p = 0.034$ ), where sports clothing was less effective when pedestrians walked sideways than towards oncoming traffic. For the pedestrian direction task, clothing had a significant effect on direction detection distances ( $p < 0.001$ ), where all the biomotion clothing resulted in significantly longer direction detection distances than sports, yellow or black clothing (Figure 1). There was a significant effect of pedestrian orientation on direction detection distance ( $p = 0.004$ ), and a significant interaction between clothing and orientation ( $p = 0.032$ ), where direction detection distances were longer in the biomotion clothing condition when pedestrians walked sideways than towards the driver.



**Figure 1. Pedestrian recognition and direction detection distances, as a function of clothing condition and pedestrian orientation.**

## Conclusion

Clothing incorporating retroreflective strips in a biomotion configuration, even for the thinnest strip width (0.75 cm) which can be easily incorporated into clothing, significantly improved nighttime conspicuity. These effects were evident regardless of pedestrian orientation and have significant implications for better design of clothing for walkers and runners to enhance their safety on nighttime roads.

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## Developing a Geo Artificial Intelligence Process to Assist with Programme Evaluation

Robyn Gardener <sup>a</sup>, Kurt Janssen <sup>b</sup>, Antonin Caen <sup>b</sup>, Sagar Soni <sup>b</sup>

<sup>a</sup>Fulton Hogan Ltd, <sup>b</sup>ORBICA

### Abstract

Every year in New Zealand (NZ), more than 150 people are killed or seriously injured on curves on roads in the rural network. In fact, approximately 95% more injury crashes occur on curves classified as high-risk (Abley, 2017).

A GIS mapping tool was developed to identify high-risk out-of-context curves and an evaluation commissioned to measure its success.

Identifying the extent of curve improvements across NZ over a 3-year period was a daunting proposition. A fresh approach to engineering project evaluation was required - one that didn't involve systematic investigation of all separate engineering works completed and all speed limit changes gazetted.

This paper discusses the journey to developing an automated intelligence process for evaluating out-of-context curve improvements on State Highways (SH) and the subsequent expansion of the process for high-risk curves on the local roads network.

### Overview

The analysis identified a total of 40,563 out-of-context curves. The programme goal was more than 85 out-of-context curves treated in total by 2022. The programme outcome was 10% fewer fatal and serious injuries at rural road bends 5-years post-implementation.

A tool for monitoring treated curves was developed, but requiring roading managers to maintain the database was not reliable.

### Discussion

The alternative method proposed automatically mining crowd-sourced data and developing maps identifying changes between the initial underlying data set and the newly aligned road improvements as they came into use and provided changed data numbers.

The methodology identified where curve changes had occurred, compared and contrasted maps from two time periods, and extracted curve sections on those data sets. Open Street Map (OSM) was selected due to its open-source nature and frequent community updates. Data sets from 2012 and 2019 were chosen for the comparison.

The client supplied a curve layer listing all curves on the NZ network, allocated into categories of straight, desirable, acceptable, unacceptable and undesirable, with straight being any road section that wasn't a curve. The curve data layer was applied, identifying all existing curves on the NZ network and discounting other road features.

Twenty attributes were identified to describe a curve change and applied to a data sample. Two hundred OSM GIS changes were found and on manual check, these translated to twenty actual road changes. Next, an artificial intelligence deep learning model was used to train and test the data to predict out-of-context curves. The entire network was then run after which two hundred curve changes representing actual road works were identified. Discounting false positives and false negatives, an accurate result of fifty actual road changes and locations, were identified. Speed limits from OSM 2017 were compared with OSM 2019 and changes flagged.

## Results

The first test on the SH network (May 2019), showed 216 undesirable or unacceptable curves treated. Figure 1 shows the curve change breakdown and the contribution speed limit reductions, geometric change or both have to improving curve safety.

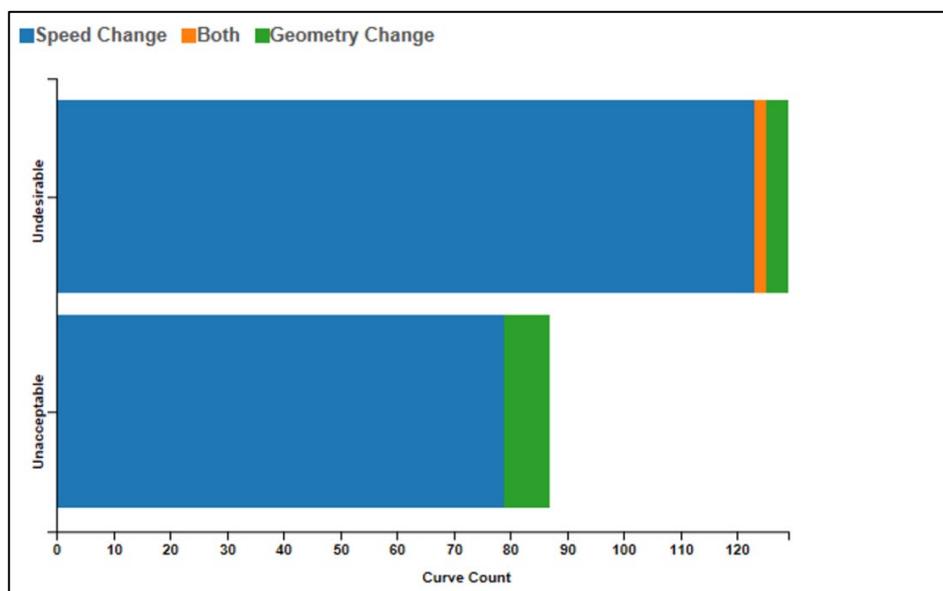


Figure 1: Treated Curve Counts

## Conclusions

With this process 70% automated, further AI model training could completely eliminate the need for manual checking. Underway are accuracy improvements including AI and computer vision with deep learning.

(500 word limit)

## References

Abley Transportation Consultants Ltd, 2017. High-risk Curves Guide: Identification, Results and Intervention.

## Pedestrian Road Safety Project

Juliet Bartels<sup>a</sup>, Jana Leckel<sup>a</sup>

<sup>a</sup> Department of Transport (Roads)

### Abstract

The Department of Transport commenced a review of pedestrian road safety to provide a deeper understanding of the factors relating to pedestrian crashes, the road safety benefits of pedestrian related rules as well community understanding and compliance with current rules. Activities include undertaking a legislative review of the Victorian Road Safety Road Rules (2017); analysis of pedestrian crash data to determine trends, patterns and causes of crashes, and how these may relate to compliance/knowledge of road rules; stakeholder and community consultation on the road safety benefits, challenges and issues for pedestrians and how they are affected by infrastructure, education and regulatory compliance. Results to date highlight the Road Rules are complex and have strengths and weaknesses. Results also show crashes involving pedestrians mostly take place when crossing the road and old and young pedestrians are more vulnerable. Community and stakeholder perceptions will be shared once engagement is completed.

### Purpose of Project

The key objective of the project is to gain a deeper understanding of factors relating to pedestrian crashes, road safety benefits of pedestrian related rules, and community understanding and compliance with current rules.

A legislative review and crash analysis was undertaken, with a literature review and community and stakeholder engagement to be completed by May 2020. The engagement phase is vital to the project, allowing us to understand views on existing pedestrian related road rules and how they are affected by the provision of infrastructure, education and compliance, and also how community views align with the safe system philosophy.

### Legislative review

The purpose of this review (Johnson, V., 2019) was to examine current pedestrian-related road rules within the Victorian *Road Safety Road Rules 2017* (Victorian Rules) and other relevant legislation; to identify strengths and weakness from a legal perspective, and opportunities for improvement. The review identified, analysed, and commented upon the Victorian Rules that apply to pedestrians in specific scenarios:

- Drivers giving way for pedestrians:
  - driving through a slip lane
  - driving through a roundabout
  - crossing at T intersections
  - turning into or at other places (footpaths, driveways, car parks, and entry or exit from trams)
  - at crossings
- General rules for drivers giving way for pedestrians at intersections.
- Drivers proceeding through a green light (vehicles) when pedestrian light is green.
- Other road rules for pedestrians (definition of pedestrian, mobile phones).

The review demonstrated the complexity of the Victorian Rules, and difficulties in attempting to identify the legal position of different road users in isolation. Victorian Rules are generally consistent with the Australian Rules, however there are differences offering alternative perspectives on given

scenarios. Rules in international jurisdictions also show alternative approaches, highlighting both weaknesses and strengths in the Victorian model.

The intent of the legislative review is to provide information about the current state of the Victorian Rules to inform future discussion by government, and relevant stakeholders.

### **Crash data analysis**

VicRoads extracted crash data on pedestrian fatalities and serious injuries between 2009-2018 (McIntyre, A., 2019). Overall, 5,826 pedestrians were killed or seriously injured in a total of 5,675 crashes.

#### **Key findings:**

- Traffic controls were present at many intersection crashes indicating they do not, by virtue of their presence, protect pedestrians.
- The crash profile for children differs from the general population
- Pedestrians under 18 and over 60 years have a higher likelihood of being killed or seriously injured in their local postcode.
- Crossing at an intersection is the largest contributor to older pedestrian trauma.
- 50 and 60 km/h speed zones in built-up areas are problematic for pedestrians.
- Failing to give-way and comply with traffic signals may contribute to pedestrian trauma (data not definitive).
- An observational study or survey methodology is required to understand knowledge of and compliance with pedestrian related road rules.

### **Next Steps**

Undertake Stakeholder engagement and literature review. Findings from all elements of the project will be considered in making any recommendations on pedestrian related road rules and legislation.

### **References**

- Johnson, V., 2019. A review of road rules and legislation affecting pedestrians in Victoria.
- McIntyre, A., 2019. Pedestrian Crashes in Victoria, 2009-2018.

## **Assessment of CSG Operator driving related transport incidents and impact of implementing In Vehicle Monitoring Systems (IVMS) on incident frequency.**

Rowena Lamond<sup>a</sup>

<sup>a</sup>Origin Energy

### **Abstract**

Previous research has highlighted that work-related road safety is an area that requires further attention with a focus on developing research informed interventions aimed at producing significant cost and efficiency savings to industry, whilst in parallel improving road safety outcomes for workers and community. The implementation of In Vehicle Monitoring Systems (IVMS) is one such intervention. Origin Energy installed IVMS in their vehicle fleet in 2011 (2010: 4,849,000 km driven by 231 vehicles) to assist in the reduction of work related road incidents. This study reviews the impact that decision had on incident frequency. Road related incident frequency rates were reduced by approximately 60% since the implementation of IVMS in 2011 (Ratio Rate = 0.395, CI 0.230 to 0.721). The study makes recommendations for further analysis of work-related driving incidents to better understand driving behaviour and to establish a cost-benefit relationship for intelligent transport systems (ITS) such as IVMS.

### ***Background***

In 2010, Origin's transport risk rating was "Very High", having driven approximately 4,849,000 km throughout Queensland's Surat and Bowen Basins and had experienced 24 incidents related to travel and transport. Origin Energy installed IVMS in their vehicle fleet in 2011 to assist in the reduction of work-related road incidents.

There is a well-established relationship between road related incidents and work (DIRD, 2017; Safe Work Australia, 2017). As reported by the Department of Infrastructure and Regional Development (DIRD), on average, employees drive over double the distance of non-work-related drivers (per annum) and have about 50% more incidents (2017). Current research indicates that IVMS can assist in the reduction of road related incidents through the monitoring of fatigue, speed, seat belt use and road hazards, for example cornering/rollover potential (IOGP 2017).

### ***Method***

This study was designed to assess the effect of IVMS implementation had on driver behaviour and performance, insofar as it affected road related incident frequency and rate. This retrospective quasi-experimental uncontrolled before and after study was conducted using a simple A B design, where "A" and "B" referred to the baseline (IVMS absent) and intervention (IVMS present) phases, respectively. Both phases were 52 weeks in duration. Baseline (A) and intervention (B) phase incident data was analysed to calculate:

- 1) the number of incidents relevant to number of vehicles in phases A and B; and
- 2) the IOGP Motor Vehicle Crash (MVC) rate equation (see Figure 2) for phases A and B.

For both 1 and 2, the ratio of the pre- and post IVMS rates, the risk ratio (RR) was calculated to determine the ratio of the probability of road related incident occurring in the intervention group (B) to the probability of the event occurring in the baseline group (A).

### **Results**

For the vehicle incidents (1) in the intervention group (B), the RR = 0.384, and CI 0.215 to 0.687 which is significant. The vehicle incident rate was reduced by 61% after the intervention. This reduction was significant ( $p < .05$ ).

For the Motor Vehicle Crash Rate (MVCR) (2), incidents per million km, in the intervention group (B), the RR = 0.395 and CI 0.230 to 0.721 which is significant. The MVCR (2) was reduced by 60% after the intervention. This reduction was significant ( $p < .05$ ).

### **Conclusions**

The results presented above demonstrate the protective nature of IVMS as a control for preventing road related incidents. Since its introduction in 2011, there has been a 60% reduction in road related incidents in vehicles that have IVMS installed. This is an important validation of this safety critical control for Origin, and for other users of IVMS.

Studies like this one have driven car manufacturers to install IVMS as standard, allowing the public to have access to safety related pre-and post-crash data from their vehicles (Doecke, 2017).

The author recommends further research to ensure IVMS continues to be worthwhile when balanced against developing safety technologies such as “driverless” or automated vehicles.

### **References**

- Department of Infrastructure and Regional Development. (2017). *Road death Australia*. (January 2017). Retrieved from <https://bitre.gov.au/statistics/safety/>
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## **Transurban Queensland motorbike incident response trial**

Angelo Lambrinos

Transurban Limited

### **Abstract**

Recognising the risk to drivers involved in a road incident and the challenges of responding in peak times, Transurban Queensland launched an Australian first Incident Response Motorbike trial in late 2018.

The aim of the trial was to improve initial on scene response times and clearance times, to reduce congestion around incidents and improve the performance and reliability of the road network and safety of all motorists.

The motorcycles have demonstrated an important use in getting through congestion sooner than other vehicles and provide basic support to motorists including fuel and water. At the same time making an assessment to ensure the response team know exactly what is happening at the scene.

This presentation will focus on the significant safety benefits that have resulted from the trial – including reduced clearance and response times and the impact this has on motorists in the event of a breakdown or incident.

### **Background**

With around 300,000 trips on the Logan and Gateway Motorways each day, Transurban Queensland's incident response (IR) crews respond to an average of 24 incidents a day.

Transurban Queensland has the largest dedicated traffic incident response fleet in the country, with more than 50 incident response officers and 20 fleet vehicles across its six roads and tunnels. Each year the incident response teams respond to around 1,000 incidents including break downs, out of fuel and debris clean up.

Two motorbikes were initially deployed to provide supportive first contact to motorists along 64km of the Logan and Gateway motorways with the aim to help reduce response and incident clearance times.

The trial sought to demonstrate the effectiveness of motorbikes as response units to incidents during peak times, when congestion can cause delay. The aim of the trial was to maximise safe lane availability and ensure the safety of motorists and first responders. Similar services have and continue to be used in the United Kingdom<sup>i</sup>, United States of America and Japan; however, this was the first for this type of service in Australian modern motoring.

In developing the trial, Transurban and incident response contractor Gateway Motorway Services (GMS) collaborated closely with Queensland Police Service, the Department of Main Roads and the Public Safety Business Agency.

### **Motorbikes and first responders – a safety first approach**

The trial looked to reduce the number of responders exposed to live traffic and eliminate current practice of stopping in a live lane when providing first response to a traffic incident, as well as in lane

work activity for the first responder. Getting to the incident sooner also means the IR motorbike crew can get the motorist and vehicle into a safe position off the motorway as quickly as possible.

State of the art equipment and training, including a new airbag vest for riders and a more puncture resistant road tyre, were included as part of the trial. The riders selected for the trial each have more than 20 years motorcycle experience. To further ensure their safety, the trial operated under strict operating guidelines. Motorcycles were only deployed during daylight hours, in peak times and when incidents resulted in congestion.

In Queensland, it is illegal for motorcycle riders to lane filter and use shoulders within congestion. This IR crew possess a Special Circumstances Permit to allow these activities and others similarly performed by police for all types of response vehicles.

The purpose-built bikes are equipped with water, diesel, petrol, a defibrillator, basic first aid, tire puncture repair kit and jump-start kits. In up to 30% of incidents, the IR motorbikes can assist the driver and get them moving safely again.

### **Response and clearance times**

The aim of the trial was to improve initial on scene response times and clearance times, to reduce congestion around incidents and improve the performance and reliability of the road network and safety of all motorists.

The motorcycles have demonstrated they are incredibly useful in getting through congestion sooner and providing basic support to motorists like fuel and water, while making an assessment to ensure the response team know exactly what is happening at the scene.

They have also been able to provide back-up support to first responders, improving clearance times to help get motorists on their way quicker and keep traffic moving.

During the trial, the motorbike crew responded to 150 incidents and helped to reduce response times to 8.5 minutes, or around 11%.

### **Conclusion**

The trial builds on Transurban's significant improvements to incident response capability on the motorways, including the introduction of a new fleet consisting of four trucks fitted with crash cushions, two tow trucks and four utes – making it the largest fleet of its kind in Australia.

The outcomes of this trial contribute to efforts to improve the safe operation of motorways.

### **About Transurban**

Transurban builds and operates roads in Australia, the USA and Canada. Our vision is to strengthen communities through transport and our road safety strategic framework is underpinned by the safe system approach. Transurban reports on its road safety KPIs, including the rate of injury crashes, and commissions independent research and analysis to inform our operations provide a safe environment for people using our network.

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<sup>i</sup> <https://www.gov.uk/government/news/fuel-for-thought-as-highways-england-launches-motorcycle-response-vehicles-on-m5>

## Motorcycle choice and self-reported crashes of Queensland motorcyclists

Ross Blackman, Adrian Wilson<sup>a</sup>

<sup>a</sup>Centre for Accident Research and Road Safety – Queensland (CARRS-Q), Queensland University of Technology

### Abstract

Research has explored relationships between crash involvement and motorcycle characteristics, including engine capacity, motorcycle type and power-to-weight ratio. The current research continues this path, focusing on results of a Queensland rider Survey in 2017-2018. The survey attracted 1290 valid responses from fully licensed riders (71%), restricted licence holders (26%) and learner riders (3%). Types of motorcycle reportedly ridden most frequently included Sport/Naked sport (52%), Cruiser (18%), Adventure (9%) Sport-touring (7%), Trail and Enduro (4%) and Touring (3%). An on-road crash in the past three years was reported by 21% of participants, with statistically significant differences by motorcycle type ( $p = .019$ ). Riders of Trail and Enduro motorcycles were most likely to report a crash (32.7%), followed by Adventure (27.1%), and Sport/Naked sport (24.6%) types. Cruiser riders were least likely to report crash involvement (14.8%). Crash involvement by motorcycle power-to-weight group showed no statistically significant results.

### Background

Motorcycle safety represents an ongoing challenge for Queensland authorities and communities, with riders and pillion accounting for 17.6% of road deaths in 2018 (Queensland Government, 2019). Historically, research examined motorcycle engine capacity as a crash risk factor, but without controlling for other motorcycle characteristics such studies are methodologically flawed (Haworth & Blackman, 2013). Greater attention has recently been paid to motorcycle type and power-to-weight ratios (PWR) in relation to crash and injury risk, finding sport motorcycles with high PWR most problematic relative to other types (Budd, Allen & Newstead, 2018). While understanding of the role of motorcycle type in crash and injury has thus increased, recent studies remain limited. The current research analysed Queensland rider survey data to further narrow the gap in relevant knowledge.

### Method

An online survey of licensed motorcyclists residing in Queensland opened 28 November 2017, closing 31 May 2018. Containing 60 main survey items, expected completion time was up to 30 minutes. Questions concerned demographics, licensing, riding patterns, motorcycle choice (current presentation focus), on-road behaviour, on-road crash history and exposure to motorcycle safety advertising. Promotion was through online motorcycle forums, government website, social media (Figure 1) and flyer distribution at Q-Ride training providers, motorcycle parking areas and product retailers. Participants were invited to enter a prize draw for one of twenty \$100 shopping vouchers.

Participants provided model details of their most frequently ridden motorcycle, from which were extracted motorcycle type and power-to-weight (PWR) categories (50 kilowatts per tonne increments).

### Results

A total 1326 submissions yielded a cleaned sample of 1290 valid completions.

The reported types of motorcycle most frequently ridden included Sport/Naked (52%), Cruiser (18%), Adventure (9%) Sport-touring (7%), Trail and Enduro (4%), and Touring (3%). Five other categories comprised less than 3% each of the total and were excluded from statistical tests. An on-road crash

in the past three years was reported by 21% of participants, with statistically significant differences by motorcycle type ( $p = .019$ ) (Table 1). Riders of Trail and Enduro motorcycles were most likely to report a crash, followed by Adventure and Sport/Naked types. Cruiser riders were least likely to report crash involvement.

Cases with valid PWR calculations were cross-tabulated with self-reported crashes ( $n=1233$ ). There was no statistically significant difference in self-reported crashes by PWR group, although at face value lower proportions of those in the middle groups (100.1 – 350.0 kW/t) reported a crash (Table 1). Of those who reported at least one crash, the mean number of crashes by motorcycle type and PWR group are also presented in Table 1.

## Conclusions

Considering numbers often reported for motorcyclist survey participation, the current research achieved a relatively large sample. Results of the analysis were partly consistent with other research (e.g. Budd et al., 2018), finding relatively high crash involvement of sport motorcycle types. However, off-road and dual-purpose types were even more prominent in self-reported crashes (noting the request to report on-road crashes only), likely reflecting the underreporting of those crashes in official datasets. Analysis of reported crashes by PWR group was inconclusive.

*Table 1. Self-reported crash involvement by motorcycle type and power-to-weight ratio (PWR)*

Motorcycle type	Reported crashing last 3 years N (%)	Mean # of crashes (if at least 1)
Sport/Naked	159 (24.6)	1.3
Cruiser	34 (14.8)	1.2
Adventure	29 (27.1)	1.3
Sport-touring	14 (15.9)	1.1
Trail/Enduro	16 (32.7)	1.9
Touring	8 (18.6)	1.4
Traditional/Classic	6 (17.1)	1.0
Scooter (>50cc)	4 (20.0)	1.0
PWR group (kW/tonne)		
25.1 - 50.0	3 (25.0)	1.0
50.1 - 100.0	27 (27.8)	1.4
100.1 - 150.0	95 (19.8)	1.3
150.1 - 200.0	18 (22.0)	1.2
200.1 - 250.0	27 (21.1)	1.4
250.1 - 300.0	17 (16.0)	1.3
300.1 - 350.0	25 (22.9)	1.4
350.1 - 400.0	22 (28.2)	1.9
More than 400.0	29 (25.7)	1.3

## Acknowledgement

The authors are grateful to Queensland Transport and Main Roads for supporting this research.



*Figure 1. Online survey webpage advertisement*

## References

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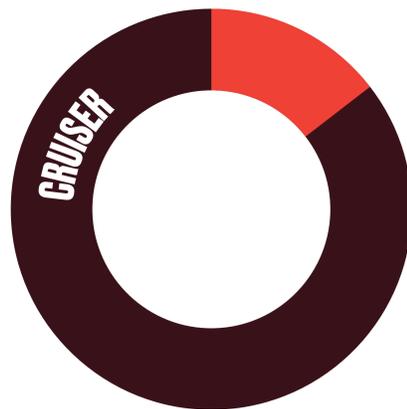
# Motorcycle **choice** and self-reported crashes of Queensland motorcyclists

Ross Blackman, Adrian Wilson

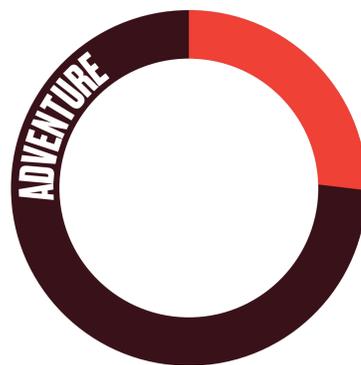
Motorcycle safety represents an ongoing challenge for Queensland authorities and communities, with riders and pillion accounting for 17.6% of road deaths in 2018 (Queensland Government, 2019). Historically, research examined motorcycle engine capacity as a crash risk factor, but without controlling for other motorcycle characteristics such studies are methodologically flawed (Haworth & Blackman, 2013). Greater attention has recently been paid to motorcycle type and power-to-weight ratios (PWR) in relation to crash and injury risk, finding sport motorcycles with high PWR most problematic relative to other types (Budd, Allen & Newstead, 2018). While understanding of the role of motorcycle type in crash and injury has thus increased, recent studies remain limited. The current research analysed Queensland rider survey data to further narrow the gap in relevant knowledge.



159 (24.6%)



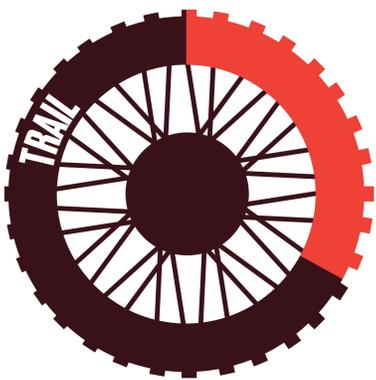
34 (14.8%)



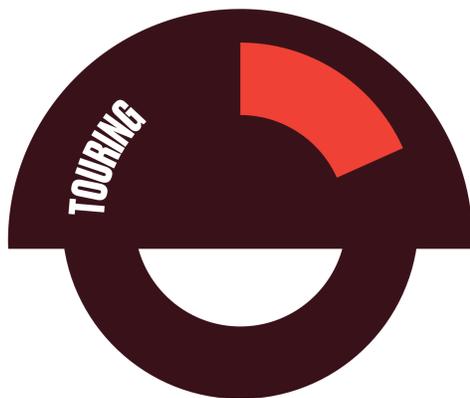
29 (27.1%)



14 (15.9%)



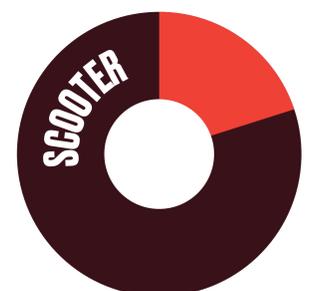
16 (32.7%)



8 (18.6%)



6 (17.1%)



4 (20%)

## Method

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Centre for Accident Research and Road Safety Queensland (CARRS-Q), Queensland University of Technology



## Developing a Black Spot Investigation Program for Kabul city Roads

Murtaza Sultani

### Abstract

With a rough data available, around 5230 people is estimated to die on the roads annually that is 15.1 people per every 100,000 populations in Afghanistan (Organization, 2018). Kabul city with around 5 million residents deals with serious road safety challenges, still there is not developed a black spot investigation program, this research investigated five major black spots in Kabul city. A rough crash data from traffic department show that five roads are the black major spots. To determine the exact spots, site visits were conducted, measuring speed, observing road users' behaviors and the road environment. The major concerning reasons were investigated. Speeding was a major factor of crashes on curves, two ways stop control at major intersections were the main factor of crashes. It concluded that speed reduction measures taken, pedestrian bridges built, and the intersections transformed to signalized with some geometric changes.

### Background:

According to Guardian report, Kabul is the fifth fastest growing city in the world (Rasmussen, 2014). With the increasing number of vehicles and population, the expected road accidents escalate rapidly. Considering this as a business case, with a 580 USD, GDP per capita in Afghanistan, the estimated cost of road fatalities in around 212 million USD and 500 million USD resulting from the serious injuries. (McMahon, 2008). There is no exact data available for property damages.

### Method:

The research on Black Spot Investigation Program in Kabul city required statistical crash data collection, site visits, data analysis, preliminary design, cost benefit analysis, prioritizing the black spots, and at the finally preparing the reports and drawing packages.

### *Crash Data Collection:*

We got some crash data from Kabul Traffic Police Department. The data were dispersed in the files mostly in papers. The required data were entered and sorted in excel files. The files consist of the data where the crash happened (approximately), when it happened (day/night), what road users were involved and from which direction and conditions at the time. To illustrate and clearly gather the missing data, the site visits with collaborations of local people near blackspots and the traffic police were essential.

### *Crash Data Analysis:*

Each blackspot was inspected and analyzed fully. To identify the crash factors, sites were visited. The patterns in the crash data were investigated. Then, a complete list of blackspots was prepared according to the priority and severity of the crashes. Also the crash diagram and crash factor grid were prepared to diagnose the crash problem. Finally, countermeasures were recommended for each blackspot.

### *Design and Cost Benefit analysis:*

First, a preliminary design of each blackspot was prepared. Secondly, a benefit/cost ratio for the recommendations were calculated. To calculate the benefits, crash reduction factors, the number of crashes that would be saved and the value of each crash were multiplied. Then, the costs of the works and implementing the countermeasures were calculated. Having the ratios, the sites and their

corresponding measures were ranked so that funds were spent on the sites that would return the “best value” to the city.

### ***Preparing Reports and Drawings:***

Finally, an accurate report and design package of each blackspot was prepared. Reviewing and finalizing them were done several times. Some meetings were organized with senior managers.

### **Results:**

The reports and drawings were approved by the Kabul Municipality. Around 4.0 million USD funds were allocated; 10 pedestrian bridges were built. 34 intersections were reconstructed. Currently safety has been improved considerably. Since implementation, no fatal crash has been recorded on the spots.

### **Conclusions:**

Speed reduction measures and building overpass bridges at curves improved a lot the safety of pedestrians. Redesign of intersections from circulatory to signalized type proved to be efficient.

***Table 1. Geometric Improvement of intersections along Airport Road, Kabul city***

<b>Black Spots</b>	<b>Crash Reduction Factors</b>	<b>Measures</b>	<b>Results</b>
Shaheed Intersection	-Dismanting of existing structures. -Road bed excavation	1.Redesign and change Two-way stop control intersection to Signalized. 2.Reduce turning radii. 3.Chanelization of routs 5.Other Geometric Imprvoements	No fatal crash has been recorded yet on the intersections.
Saleem Karwan Intersection	-Back filling -Subgrade prepration -Pavement		
Taimani Intersection	-Procure and Install: <ul style="list-style-type: none"> <li>• interlooks</li> </ul>		
Baraki Intersection	<ul style="list-style-type: none"> <li>• signage</li> <li>• guidestons</li> <li>• railings</li> <li>• Actuated Signals</li> </ul>		
Traffic Intersection	-Reconstruct the road ditch -Pedestrian Crossing Marking -line markings -Procure and Install bollards and ramps at pedestrian crossings.		

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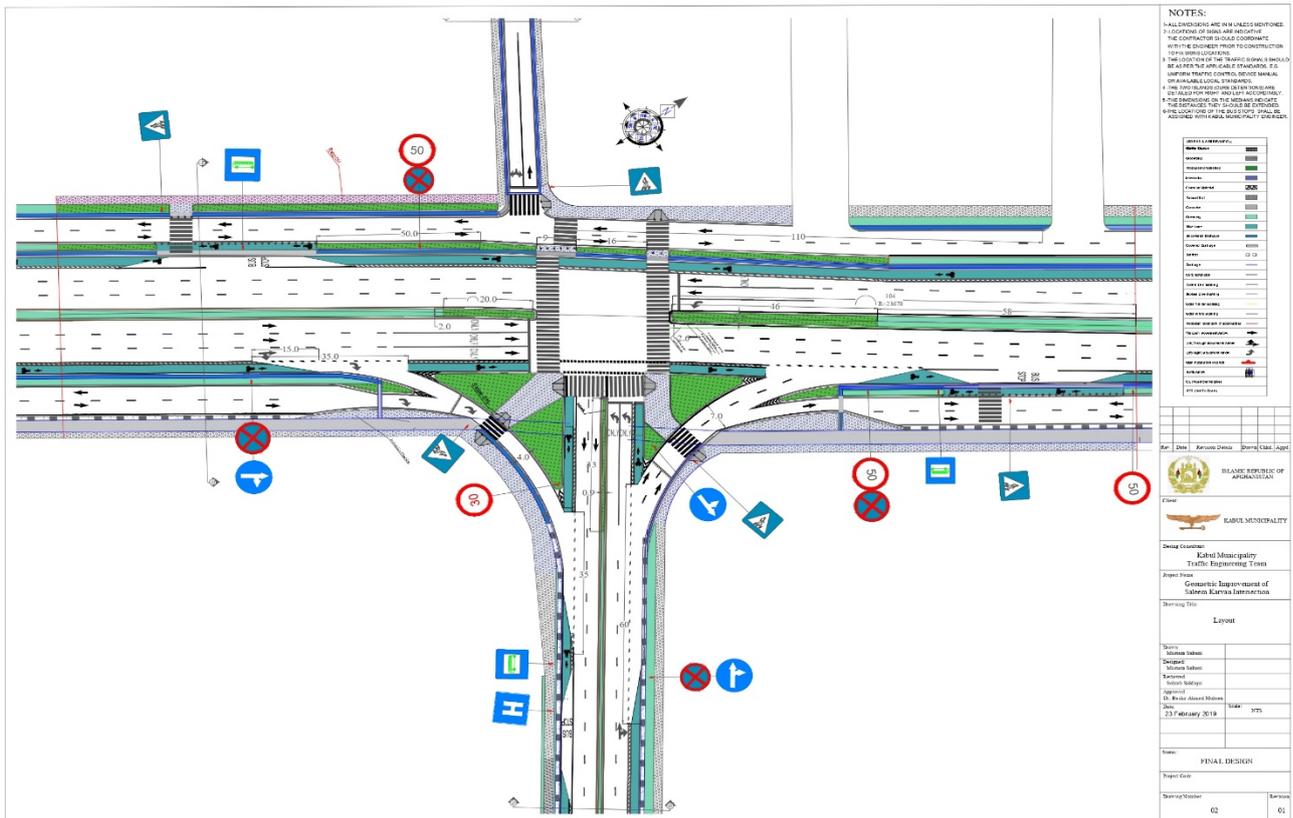
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**Figure 1. Example of a previous big circulatory intersection in Kabul city, Airport Road**



**Figure 2. Example of Redesigning a circulatory intersection to a Signalized Intersection in Kabul city, Airport Road, Layout on GIS map, Saleem Karwan Intersection**



**Figure 3. Example of transforming a circulatory intersection to a Signalized Intersection in Kabul city, Airport Road, Detailed Redesign, Saleem Karwan Intersection**

## Medical fitness to drive: development of transport and medical practitioner partnership to enhance road safety

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### Abstract

Drivers with medical conditions and disabilities represent a significant proportion of our driving community. During 2017, several coroner reports on deaths without inquest involving drivers with established medical conditions triggered the need for closer collaboration with peak medical bodies to understand medical fitness to drive issues, medical review processes and road safety risks. We applied an evidence based and action research approach involving participant engagement at every stage to interrogate the issues. The expert action group guided discovery work, a systematic literature review and countermeasure investigations. Despite national medical fitness to drive (FTD) guidelines (available since 1998), we identified gaps in medical practitioner knowledge and skills, low driver awareness and other systems factors. The group committed to a further three year term to continue delivering FTD outcomes demonstrating true application of across domain collaboration to achieve road safety benefits – as reflected by "Towards Zero – A Fresh Approach".

### Background and Aims

About 18% of Australians have a disability or chronic medical condition (AIHW, 2019). Many will be drivers seeking to retain driving independence (Dickerson et al., 2017) however safety risks require management (Mitchell et al, 2020). Responding to six separate incidents over a 2 year period involving drivers with significant medical conditions, several Victorian Coroners recommended introducing mandatory medical reporting of drivers with FTD issues to medical review. Mandatory reporting is not legislated in Victoria. VicRoads worked with relevant medical practitioners (MPs) to (a) better understand barriers/facilitators impacting FTD processes, (b) interrogate systematically the research evidence base for mandatory medical reporting, and (c) identify/develop strategies to address gaps. This acknowledged that regulatory approaches may not consider broader health systems issues impacting on patient management of FTD (Austroads, 2016).

### Methods

Action research prioritises stakeholder expertise and engagement in phenomena investigation to develop meaningful countermeasures, optimising outcome application and ownership (Koshy, et.al. 2010). Adopting the Safe System approach: safe people (WHO, 2011), activities and research involved collaborating with medical experts and consumer groups to (a) conduct a gap/situational analysis and investigation of FTD and medical review processes, (b) inform/implement a systematic literature review to identify benefits and risks of mandatory medical reporting, and (c) validate needs and develop resources to enhance FTD awareness, knowledge and skills.

### Results and Knowledge Translation outputs

We identified that:

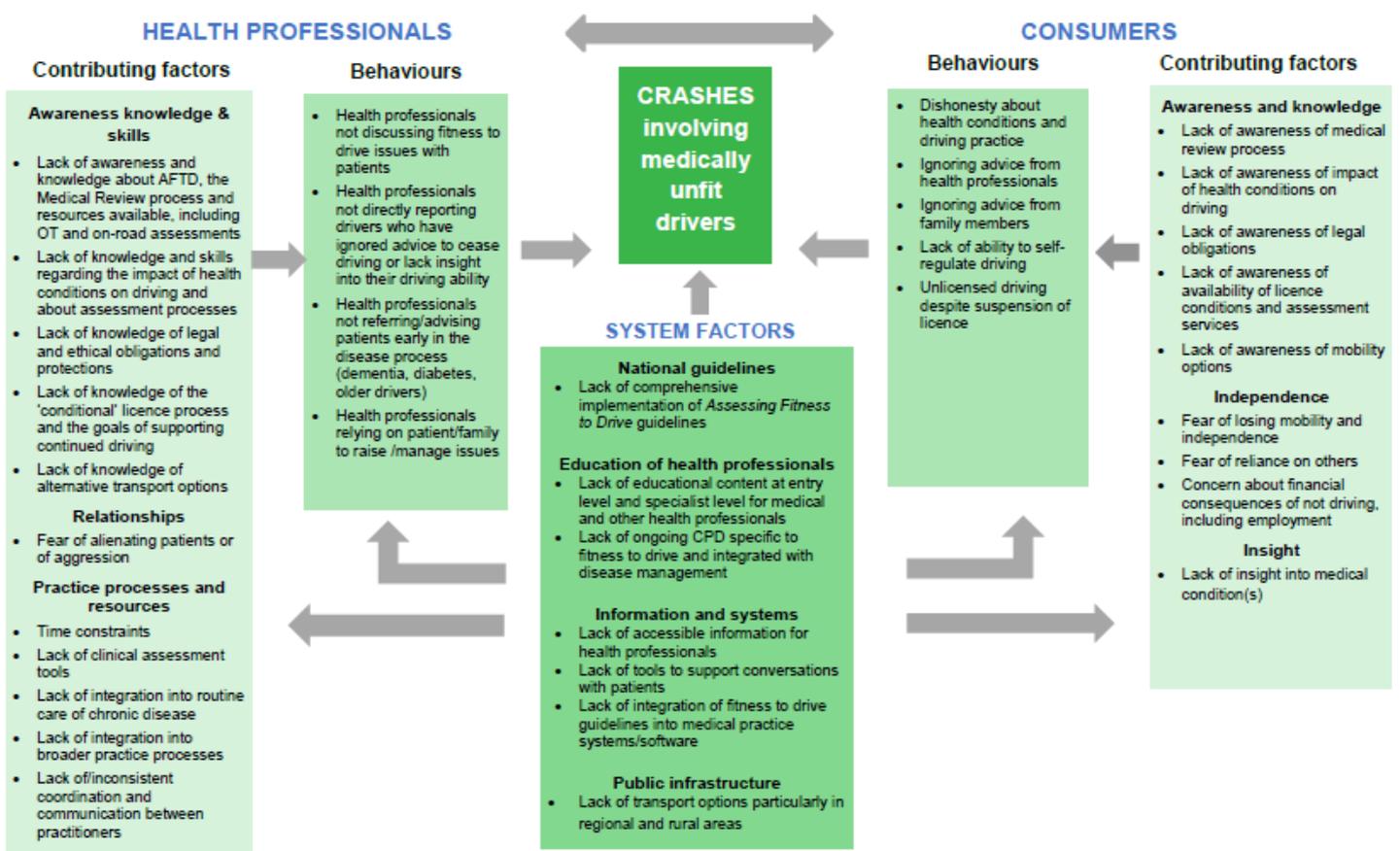
- complex system-related factors impact on current FTD self-reporting (Figure 1),
- MPs are critical in FTD processes but awareness of road safety risks/repercussions and application of guidelines/resources varies,
- existing FTD MP resource gaps, and

- patients rely on MPs to provide FTD information: repeated discussions enhance effective community mobility management.

Systematic review findings (now published: Koppel, et.al, 2019) identified that mandatory reporting increases MP FTD awareness but impacts negatively on doctor-patient relationships and public health (e.g. drivers not seeking treatment for fear of reporting/licence loss, Elgar & Smith, 2018). There was inconclusive evidence of mandatory reporting benefits for reducing crash risk.

Actions taken to enhance FTD resources/education included:

- implementation of MP engagement plan including communication activities,
- addressing barriers via development/upgrading of MP/patient web-pages, fact sheets and clinical resources, and
- engaging with the National Transport Commission/Austrroads re issues impacting on FTD guideline use and implementation opportunities.



**Figure 1. FTD Situational analysis: examples of factors contributing to lack of compliance with current self and community reporting to Medical Review**

### Conclusions

Working group members valued opportunities to strengthen aspects of Victoria’s FTD system and have committed to continuing collaborations. Intervention effectiveness measures are underway: preliminary results reflect self-referral increases to medical review. Utilising action research methods, we (a) developed a clearer understanding of FTD issues impacting on MPs and drivers, (b) confirmed the evidence base for the self/community model of FTD referral, and (c) developed/enhanced resources to support MP-patient FTD conversations and clinical processes ultimately enhancing road safety. This is the first time internationally that a set of complimentary

FTD-related resources are available in internet repositories for MPs, users/consumers and public access.

### **Acknowledgements:**

Peak Medical Practitioner and disability/advocacy groups for in-kind support.

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VicRoads Fitness to Drive webpages:

- (a) for Health professionals: <https://www.vicroads.vic.gov.au/licences/health-and-driving/information-for-health-professionals>
- (b) for Drivers with medical review issues: <https://www.vicroads.vic.gov.au/licences/health-and-driving>

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## **Bus passenger protection – Are We There Yet? After 30 years what are the new challenges to bus safety.**

Carl Liersch

General Manager, APV-T Engineering and Testing Services

### **Abstract**

Bus Safety has taken enormous strides forward in the last thirty years. Road infrastructure has improved on many highways to reduce the likelihood of a bus “run-off road” or bus to vehicle crash. Vehicle technology has improved with increased safety features included in bus specifications. Driver training and driving regimes have been revamped to reduce driver fatigue. Additionally bus seating with integrated safety belts have been introduced.

But are we at risk of losing some of what we have gained through the fast-paced change in Bus manufacturing and the components used within such vehicles?

This paper reflects on the past, and the many improvements made over the last three decades. It also examines some potential risks manifesting themselves within the bus industry and includes suggestions as to what we may be able to do to avoid losing some of the great gains that have been achieved in recent years.

### **Introduction**

1989 was a very bad year for road fatalities. Most significantly because of two bus crashes only two months apart in Kempsey and Grafton. Together 55 people lost their lives from these two horrific crashes with many road safety representatives declaring that this must never happen again.

Only four years later another bus crash occurred on the Hume Highway near Wangaratta in Victoria killing nine people and injuring a further 35.

Moving on to 30 years later and we can look back on a lot of great improvements to bus passenger safety led by accident researchers and forensic investigators. All three pillars of road safety have been addressed at some level i.e.: 1. Road infrastructure; 2. The human factor and; 3. Vehicle technology. In short, the work completed to date appears to be a good example of a systems approach to a safety challenge.

But is this enough? Can we say that bus accidents like those in the past won't happen again? Can we guarantee the safety of passengers should an accident occur? What more needs to be done?

### **The Challenge.**

A review of policy reveals that the topic of bus safety is taken very seriously across Australia and New Zealand and statistics show that bus transport is the safest mode of road transport in Australia.

But the industry is changing. As global manufacturing dynamics have shifted in the last few decades we see also a shift in the supplier base of bus components, with new bus manufacturers building buses in Australia or importing them from elsewhere in the world to sell into the New Zealand and Australian markets.

With this change comes the risk of slipping safety levels. This can be manifest not by the requirements of the markets and the high standards already set, but by the ability of the industry to control the quality of various components from suppliers.

In recent months evidence has been gathered that show and demonstrate that some critical safety components on some new buses, such as safety belts and how they are installed, are not certified and tested as claimed. The declarations of conformance are in some cases missing, or at worst – fake, and the product supplied is sub-standard putting at risk the high safety standards already achieved in the bus industry.

### **Conclusion**

Recently investigations and inspections by authorities such as Bus Safety Victoria have begun to highlight the concerns raised by industry experts. A safety blitz in Victoria in late 2019 highlighted specific concerns related to the inspection regime at the time that concentrated on vehicle roadworthiness and driver qualification.

What is found in random inspections is only ever a snapshot of the overall system, but it indicates that continued focus by authorities is a “must”, and that we all need to be vigilant and keep to the high standards that are necessary to ensure the highest level of bus safety is maintained.

## Speeding insights from the CASR EDR study

Martin Elsegood<sup>a</sup>, Sam Doecke<sup>a</sup>, Giulio Ponte<sup>a</sup>

<sup>a</sup>Centre for Automotive Safety Research

### Abstract

Travel speed data retrieved from vehicles with event data recorders (EDR) were matched to police reports and hospital records, allowing insight into driver behaviours. Details of 316 cases were collected and categorised into crash types and movement groups. Vehicles travelling at self-selected, unhindered, free speeds immediately preceding the crashes were shown to be speeding in 36.1% of cases. Males were shown to have a slightly higher proportion of speeding from the sample, but speeding was shown to be statistically significantly more prevalent with drivers aged below 40 years old.

### Background

Event data recorders (EDR) that are installed in many modern vehicles record data such as travel speed, accelerator and brake pedal status, seat belt usage, and steering angle in half-second increments for up to five seconds preceding a crash. The traditional method of speed determination by crash reconstruction can be limited by a lack of physical evidence and is resource intensive. EDR data allows deeper and more accurate insight into the speed behaviours of drivers prior to a crash.

The Centre for Automotive Safety Research's (CASR) EDR study that began in 2017 has collected a large sample of EDR data from crashed vehicles. The aim of this project was to analyse the CASR EDR data to estimate the proportion of speed related crashes in South Australian and the corresponding driver demographics.

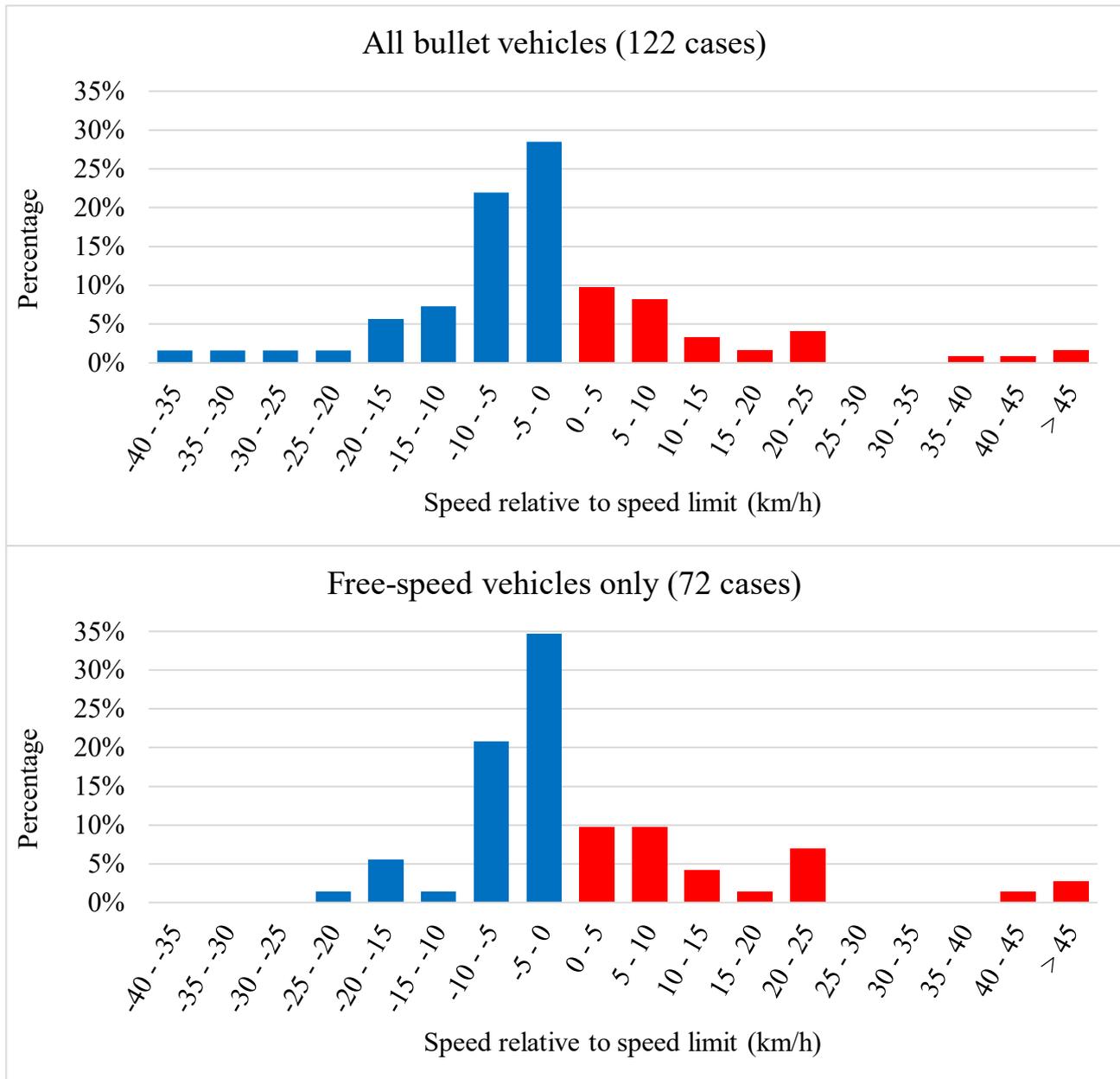
### Method

CASR has collected a large sample of EDR downloads from vehicles accessed through Pickles Auctions (an auctioneer of crashed vehicles). Around 80 to 90% of insured written off vehicles from South Australia reportedly go through the holding yard. The vehicle details, EDR downloads and vehicle damage photographs are used to match the vehicles to police reports, and subsequently match the occupants of the vehicles to hospital records.

A total of 316 vehicles were successfully downloaded from and matched to police reports. For the purposes of this study, the travel speeds and crash configurations of each vehicle was assessed and categorised into movement groups to determine which vehicles were travelling at a self-selected, free speed (unhindered by other traffic and not performing a manoeuvre) and which vehicles were bullet vehicles prior to the crash (as opposed to target vehicles, and are usually travelling around the road speed limit). Free-speed vehicles excluded all rear-end crash-involved vehicles as the chosen speeds of rear-end crash-involved vehicles are presumed to be affected by traffic flow.

**Results**

There were 122 vehicles in the sample classified as bullet vehicles, with 30% travelling above the speed limit. This increased to 36% when only considering the 72 free-speed vehicles. The distributions of bullet and free-speed vehicle speeds relative to the speed limit are shown in Figure 1.



**Figure 1. Bullet and free-speed vehicle maximum travel speed relative to speed limit**

The distributions of non-speeding and speeding cases of bullet vehicles and free-speed vehicles by sex and age of driver are disaggregated in Table 1. In all bullet vehicles and free-speed vehicles, males had a slightly higher proportion of speeding than females. In the free-speed vehicles only, the younger age groups (below 40 years old) had a speeding rate of 51%, compared to 18% for the older age groups (above 40 years old). The difference between age groups in the bullet vehicles were not as considerable, with the same younger age group speeding rate of 42%, compared to 13%. Both age range comparisons were statistically significant using a chi-squared test.

**Table 1. Bullet and free-speed vehicle driver sex and age of speeding and non-speeding vehicles**

<b>All bullet vehicles</b>							
Speeding category	Sex		Age group				Total
	Female	Male	16-24	25-39	40-64	65+	
<b>Not speeding</b>	42	43	21	22	37	5	85
<b>Speeding</b>	16	21	13	18	5	1	37
<b>Percentage speeding</b>	27.6%	32.8%	38.2%	45.0%	11.9%	16.7%	30.3%
<b>Total</b>	<b>58</b>	<b>64</b>	<b>34</b>	<b>40</b>	<b>42</b>	<b>6</b>	<b>122</b>
<b>Free-speed vehicles only</b>							
Speeding category	Sex		Age group				Total
	Female	Male	16-24	25-39	40-64	65+	
<b>Not speeding</b>	21	25	6	13	26	1	46
<b>Speeding</b>	11	15	9	11	5	1	26
<b>Percentage speeding</b>	34.4%	37.5%	60.0%	45.8%	16.1%	50.0%	36.1%
<b>Total</b>	<b>32</b>	<b>40</b>	<b>15</b>	<b>24</b>	<b>31</b>	<b>2</b>	<b>72</b>

## Conclusion

Data collected from EDR vehicles indicated 36% of free-speed vehicles were travelling above the speed limit. Drivers under the age of 40 years old are statistically significantly more likely to be speeding in both bullet vehicles and in free-speed vehicles.

## **Motorised Mobility Device use: Consensus based non-regulatory countermeasures to enhance user road safety**

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<sup>a</sup>Road Safety Victoria, Australia, <sup>b</sup>Project Health, Melbourne, Australia, <sup>c</sup> Austin Hospital, Melbourne, Australia.

### **Abstract**

Motorised Mobility Devices (MMDs) including powered wheelchairs may enable people with limited walking capacity to enhance community participation, however user safety is a consideration. Rider licensing and MMD registration processes are unsuitable considering the health systems context of MMD procurement and use. MMD users present with differing impairment states requiring a health framework approach encompassing user suitability assessment, MMD prescription and training, and ongoing review. These processes have the potential to underpin and enhance safety on our road system, addressing Pillar 4 (Safer road users) of the UN Decade of Action for Road Safety Global Plan and contributing to 'Towards Zero' goals. Following a literature review and stakeholder consultation, we identified gaps in resources and tools to support evidence based assessment, prescription and review processes considering safe system principles. Using action research approaches and targeted surveys, we established content validity for tools and resources ready for trialling by health practitioners.

### **Background and Aims**

MMD users generally have physical impairments impacting walking capacity: in Victoria only individuals with impairments (or staff undertaking training) are legally able to use MMDs on road infrastructure. The independence and safety of users with impairments relies on a safe system approach: optimising safe human-machine interfaces via user needs assessment/capacity evaluation, prescription (matching needs to MMD design and use environment), training and ongoing monitoring. As our population increases, more MMD users will benefit from mobility independence (Labbe et al, 2018) but also potentially face road safety risks (e.g. Kitching Labbe et al, 2015). Queensland is currently the only Australian jurisdiction requiring registration of MMDs used on the road network. Benefits of such regulatory approaches are unknown and in isolation may not address broader health systems issues impacting on MMD procurement, training, use and monitoring: innovative collaborations across health and road safety sectors are needed (NTC, 2019).

Our research focussed on (a) understanding the MMD user within the Safe System Approach to better appreciate pathways and processes for procurement, use and training, (b) gap analysis and investigation of non-regulatory safety interventions, and (c) developing and trialling resources to confirm practicability of methods.

### **Methods**

The action research study design included a literature/resource review, user pathway, gap and ergonomic task analysis, and consultation with a stakeholder advisory group (SAG) including Occupational Therapists (OTs) (key health professionals servicing MMD users) and MMD users. Surveys investigating OT clinical experiences and capturing feedback on MMD resources also provided data. Action research processes utilise stakeholder expertise to investigate phenomena, develop meaningful outcomes and optimise ownership and application of results (Koshy, et al. 2010).

## Results and Knowledge Translation outputs

Key findings from methods including 2 surveys which were SAG ratified (n= 58 occupational therapists: MMD clinical practice, n=18, MMD stakeholders: resource survey feedback) included:

- many users are aged under 60 years, many have several health conditions,
- users with cognitive/intellectual impairments and/or who are older/with multiple co-morbidities are most vulnerable regarding collision/incident risk and negative outcomes including death,
- factors contributing to crashes/incidents are complex,
- gaps in acquisition/use pathways may predispose users/community to road safety risks (Table 1),
- importance of assessment/training of users, health professionals and the public re:safe devices, behaviours, environments,
- clinical and education resources are scattered, outdated, lack road safety content, and
- intervention effectiveness not support by high-level evidence to improve safety.

Prioritised non-regulatory options for addressing road safety gaps (SAG ratified) included:

- user journey and clinical process development for assessment and prescription,
- upgrading several tools, education and clinical resources to support clinical and user processes, and
- tool and education resource repositories for consumers/users, OTs/other health care professionals.

*Table 1. MMD acquisition/use existing pathways*

<b>Purchase methods</b>	<b>User capacity assessment</b>	<b>Education resources</b>	<b>Practical training</b>	<b>Future capacity monitoring</b>
<b>Supplier direct</b>	Limited	Variable	Limited	Unknown
<b>Second hand: Self/family/carer</b>	Unknown	Unknown	Unlikely	Unknown
<b>With OT prescription</b>	Variable	Variable	Variable	Variable

## Conclusions

Utilising action research methods, we (a) developed a clearer understanding of MMD pathways and processes for procurement, use and training, and (b) identified, developed/enhanced and trialled non-regulatory methods to support clinical processes, education and road safety. This is the first time internationally that a set of complimentary MMD-related resources are available in internet repositories for users/consumers, clinicians and public access. User and community safety is the ultimate goal.

**Acknowledgements:** Peak disability groups for in-kind support.

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## Perceived factors associated with boda-boda (motorcycle) accidents in Kampala, Uganda

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### Abstract

According to the United Nations, nearly 1.25 million people are killed and up to 50 million people are injured on the world's roads every year. Uganda loses about 10 people daily to road accidents, costing about US\$1.2 billion annually which represents about 5% of the GDP. The objective of this study was to identify causal factors that can be associated with boda-boda accidents in Uganda.

A cross sectional study assessed 200 boda-boda riders in the urban areas of Kampala, Uganda. Interviews using semi-structured questionnaires were administered to all participants. Data collected was entered in excel and imported to STATA for analysis. Multivariate and bivariate analyses were conducted to determine factors that influenced accident risk perception. All variables which were significant at bivariate level and thought to be theoretically important in influencing the outcome variable were included in a logistic regression model. All tests were performed at a significance of  $P < 0.05$ .

Competition for passengers with other public transport operators (83%), negligence of road safety rules (78%) and inadequate helmet usage (62%) were the main factors perceived to be associated with boda-boda accidents. Other factors identified by the respondents include age of the boda-boda rider (58%) and drug use (56%) ( $P < 0.05$ ). At multivariate analysis, competition for passengers (AOR 17, 95%CI 1.34-26.5) and being in between 18-25 years old (AOR 19, 95%CI 1.42-27.1) remained statistically significant.

This study revealed behavioral factors by all public transporters as the main factors associated with boda-boda accidents in the Urban Kampala. This demonstrates the need for holistic interventions to address such boda-boda accidents in Uganda. Such interventions can be through digitization of transport system for clients to engage remotely with the transport operators, routine refresher trainings of all transport operators and construction of lanes for boda-boda riders.

### Background

Globally Road Traffic Accidents (RTAs) are a major public health concern associated with deaths, injury and social suffering (Beshsah & Hill, 2010). Nearly 1.25 million people worldwide are killed and up to 50 million people are injured on the world's roads every year (Toroyan, et al., 2013). Despite the United Nations Development Programme target to reduce traffic deaths and injuries by 50% by 2020 (Toroyan et al., 2013), it still presents a serious public health threat with technological advancements in the transport sector including use of boda-boda (motorcycles) (Moyer et al., 2017). Consequences of road traffic accidents are mainly reflected

in the social sphere (for instance financial hardships) and mainly affect the direct participants of road traffic accidents and their families (Masilkova, 2017). In developed countries like United Kingdom, RTAs claim about 3000 human lives annually caused mainly by human factors including drug abuse, over speeding (Clarke et al., 2010). This includes motorcycle accidents though their proportion is not clear.

In developing countries, RTAs are among the leading cause of death and injury (Beshah & Hill, 2010 & Issa, 2016).

In Asian countries like India, about seven million people suffer RTAs with associated costs of about 2% of the GDP (Shami, 2016). Violation of traffic rules by drivers is the main factor associated with these accidents in India (Shami, 2016). Increased usage of cars and the highly changing nature of transportation is linked to the increasing RTAs in India (Mittal, 2008). In Indonesia, human factors like consumption of alcohol by drivers are highly cited to be the main cause of accidents (Soehodho, 2017). In countries like Malaysia and Thailand, the nature of roads are pointed out by World Health Organization to be the most dangerous to drivers and contribute to most of the accidents (Murad, 2014). Human factors like over speeding and alcohol consumption are also associated with Road Traffic Accidents in these countries – Malaysia and Thailand (Redhwan & Karim, 2010).

Studies in Saudi Arabia point out human related factors including drug abuse and failure to follow traffic rules to contribute to about 80% of the RTAs (Issa, 2016).

In African countries like Nigeria, human related factors like drug abuse by motorcycle drivers are linked to RTAs claiming human lives (Osifo et al., 2012). Similarly, studies undertaken by (Raynor & Mirzoev, 2014) in Kenya indicate human factors like alcohol consumption and inadequate use of helmets by motorcycle drivers to be the main cause of accidents. In Libya, age and gender has been cited to be associated with Road Traffic Accidents with females and youths often violating traffic regulations (Yahia et al., 2014).

Uganda loses about 10 people daily to road accidents, costing about US\$1.2 billion annually which represents about 5% of the GDP (Toroyan et al., 2013). Studies undertaken in Gulu district indicate a substantial burden due to RTAs which includes motorcyclists (Boda-Boda) (Pebalo et al., 2012). In national referral hospitals like Mulago in Uganda, Road Traffic Accidents (RTAs) are the main cause of trauma with boda-bodas involved in about 41% of all trauma patients (Kigera & Nguku, 2010). Studies by (Kigera & Nguku, 2010) on the Impact of Bodaboda Motor crashes on the budget for clinical services at the main national referral hospital in Uganda indicate consumption of about 62.5% of the budget allocation for the directorate of surgery (Kigera & Nguku, 2010).

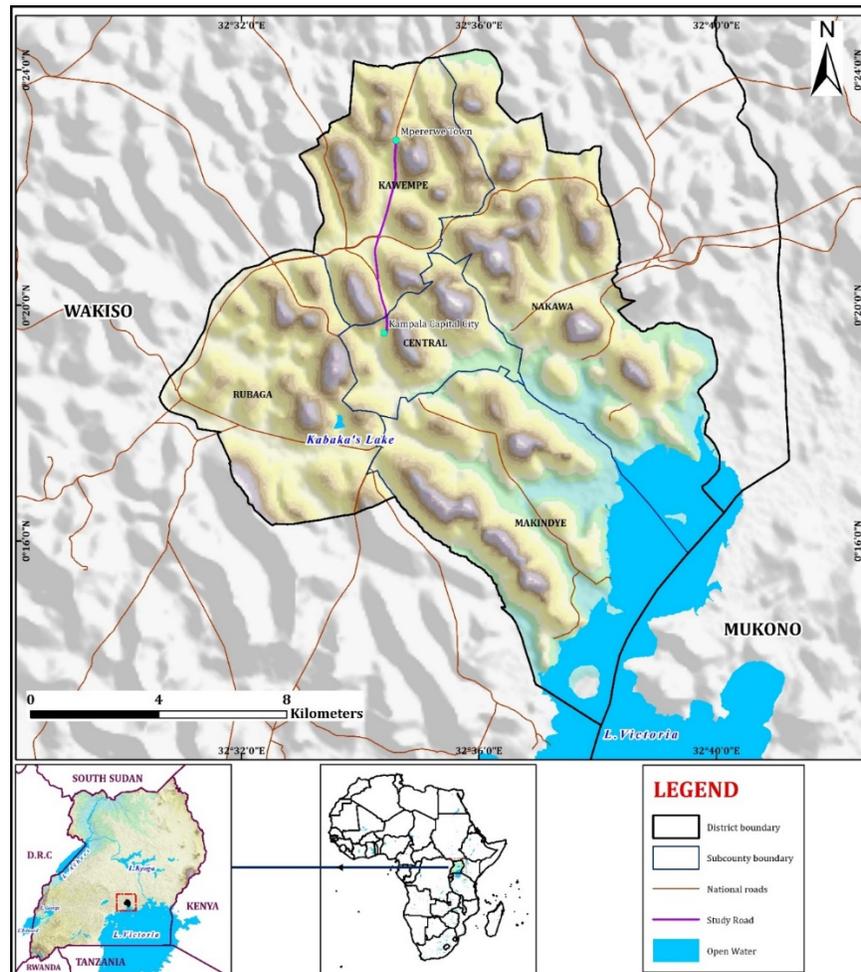
Road Traffic Accidents have evolved overtime with urbanization and technological advancements (Djahel et al., 2015 & Mooney, 2012). This includes introduction and use of Boda-boda (motorcycles) for transport especially in developing countries like Uganda. (Mooney, 2012) predicts that such technological advancements in transport sector will lead to increased pollution and RTAs. Risk factors often associated with boda-boda accidents include drug abuse (Gjerde et al., 2011), over speeding (Wang et al., 2013), age (International Traffic Safety Data and Analysis Group, 2013), gender (Mohan, 2009) and poor road network (Wang et al., 2013).

Studies undertaken about in urban areas of Uganda including Gulu highlight reckless driving and riding (49%), poor road design among other factors to be associated with RTAs (Pebalo et al., 2012). Studies on RTAs and perceived associated factors have however been few and yet policy interventions would be successful if information from those directly involved in RTAs is known. This current study therefore sought to identify the casual factors that are associated with boda-boda accidents in Uganda.

**Methods**

**Study area**

Kampala (Figure 1) is the capital city of Uganda with a population of about 1.507 million people (UBOS, 2016). Kampala is a city found in Central Region, Uganda (Nannyonga-Tamusuza, 2017). It is located between 0.32 latitude and 32.58 longitude and it is situated at elevation 1223 meters above sea level (Vermeiren et al., 2012). Forms of transport mainly used include boda-boda, taxi, minibuses and private means of transport (Kamuhanda & Schmidt, 2009). Traffic jam is known to be high especially during school days and in areas near main trading centers like markets (Kamuhanda & Schmidt, 2009).



*Figure 1: Location of the study area*

### ***Study design and setting***

A cross sectional study was undertaken between August 2018 to September 2018 in the urban areas of Kampala, the capital city of Uganda (Komakech et al., 2014). The city has a population of about 2 million people with motorcycles as the most commonly used mode of transport. Semi structured questionnaires were used to interview respondents on the factors that predispose them and their clients to accidents.

### ***Sample Size Determination***

With the total number of boda-boda riders in Kampala being extremely high, a sample was drawn to represent the total number of boda-boda riders in the city. The sample size was estimated using the formula  $N = ((z^2pq)/d^2)$ , where  $N$  was the required sample size,  $z$  is 1.96 (value corresponding to 95% confidence level). The proportion of boda-boda riders who perceive themselves to be at risk of RTAs and have experienced and or have knowledge about RTAs in Kampala or both was estimated to be 15%;  $q$  is equivalent to  $1-p$  which is 0.85.  $d$  (5%) was the error allowed in this study. Upon substitutions, the sample size was equivalent to 195.9 and was approximated to 200 boda-boda riders. It's assumed that this was the best representative of the population of boda-boda riders in Kampala.

### ***Participants Recruitment***

Respondents in this study were drawn from the city center (Kampala) and in Mpererwe (Kawempe division). A transect line between Mpererwe and Kampala city center was drawn following the common roads used by boda-boda riders for business and parking. Interviews were done after every three boda-boda riders along transect. In cases where the respondent was not willing to participate, the next boda-boda rider was selected as the process continued until the total number (200) of respondents were interviewed.

Semistructured interview questionnaires were used to collect data and were administered by a research team. Questionnaires were developed by the research team based on a reconnaissance study on boda-boda industry in Kampala, Uganda. Questionnaire tools were designed with easily understandable English and was translated to Luganda – the main local language used in Kampala, Uganda.

### ***Inclusion and exclusion criteria***

Participants of this study included individuals owning motorcycles and have worked in boda-boda business Kampala for more than two years. They also had to be stationed and or, be working in the field of boda-boda business.

The assumption made during this was that all respondents (boda-boda riders) have been involved in, or have knowledge about boda-boda related accidents or both.

### ***Data Analysis***

Data collected was entered in excel, coded and imported to STATA (Version 13) (StataCorp, 2015) for analysis. Socio-demographic characteristics of respondents were summarized using descriptive statistics. Multivariate and bivariate analyses were conducted to determine factors that influenced accident risk perception. All variables which were significant at bivariate level

and thought to be theoretically important in influencing the outcome variable were included in a logistic regression model. All tests were performed at a significance of  $P < 0.05$ .

## Results

A total of 200 respondents participated in this study during the months of August to September (2018).

All the respondents 100% (200) (Table 1) were male and more than three quarters 89% (178) were in the age group of (18 – 34) years. About 6.5% (13) of the respondents were below 18 years while 4.5% (9) of the respondents were between 35-64 years. None of the respondents were above 65 years. Majority of the respondents had attained primary (46.5%) and secondary (36%) education. Only a few of them had attained advanced (11%) and university (6.5%) level education (Table 1).

*Table 1: Sociodemographic characteristics of respondents*

Variable	Frequency (N=200)	Percentage
<b>Gender</b>		
Men	200	100
Women	0	0
<b>Age</b>		
≤17	13	6.5
18-34	178	89
35-64	9	4.5
≥65	0	0
<b>Education Level</b>		
Primary	93	46.5
Ordinary	72	36
Advanced	22	11
University	13	6.5

*Primary level education – First seven years of school, secondary level education involves 6 years divided into ordinary (4 years) and advance (2years). University is one of the higher level education institution*

## Factors perceived to be associated with boda-boda accidents

A total of 152 (76%) of the respondents perceived themselves to be at risk for accidents (Table 2). Unadjusted analysis revealed that being 17 years old or less (Crude Odds Ratio (COR) 0.53, 95% Confidence Interval (CI) 0.13-0.75), being in between 26-34 years old (COR 0.21, 95%CI 0.20-0.38) and being 35 years old and above (COR 0.50, 95%CI 0.35-0.55) were perceived to be associated with accidents (Table 2). Similarly, having an helmet (COR 0.41, 95%CI 0.22-0.45), not competing for passengers (COR 0.51, 95%CI 0.35–0.79) and attending regular trainings on traffic rules (COR 0.52, 95%CI 0.43–0.95) were perceived to be negatively associated with accidents by respondents (Table 2). This implies attention to boda-boda riders of particular age groups and trainings can play a great role in reducing road traffic accidents. At multivariate analysis, competition for passengers (AOR 17, 95%CI 1.34-26.5) and being in between 18-25 years old (AOR 19, 95%CI 1.42-27.1) remained statistically significant.

**Table 2: Factors associated with boda-boda accidents**

<b>Variable</b>	<b>Perceive themselves to be at risk of accidents Frequency (%)</b>	<b>Do not perceive themselves to be at risk of accidents</b>	<b>COR</b>	<b>95%CI</b>	<b>P value</b>
<b>Age</b>					
<b>≤17</b>	9(69.2)	4(30.8)	0.53	0.13-0.75	0.001*
<b>18-25</b>	72(75)	24(25)	1.00		
<b>26-34</b>	59(77.6)	17(22.4)	0.21	0.20-0.38	0.004*
<b>≥35</b>	12(80)	3(20)	0.50	0.35-0.55	0.003*
<b>Had Helmets</b>					
<b>Yes</b>	67(78.8)	18(21.2)	0.41	0.22-0.45	0.002*
<b>No</b>	111(96.5)	4(3.5)	1.00		
<b>Used Helmets in the past 6 months</b>					
<b>Yes</b>	126(85.1)	22(14.9)	1.50	0.28-1.88	0.732
<b>No</b>	44(84.6)	8(15.4)	1.00		
<b>Knowledge of a boda-boda rider involved in an accident</b>					
<b>Yes</b>	200(100)	0(0)	1.53	0.30-1.57	0.645
<b>No</b>	0(0)	0(0)	1.00		
<b>Taken alcohol for the past one week before riding</b>					
<b>Yes</b>	91(80.5)	22(19.5)	0.87	0.33-0.96	0.645
<b>No</b>	54(62.1)	33(37.9)	1.00		
<b>Competes with other transport operators daily for passengers</b>					
<b>Yes</b>	187(98.9)	2(1.1)	1.00		
<b>No</b>	1(100)	0(0)	0.51	0.35–0.79	0.001*
<b>Attended trainings on traffic rules</b>					
<b>Yes</b>	3(100)	0(0)	0.52	0.43–0.95	0.003*
<b>No</b>	192(97.5)	5(2.5)	1.00		

### Individual involvement in an accident and factors associated

Competition for passengers with other public transport operators (83%), negligence of road safety rules (78%) and inadequate helmet usage (62%) were the main factors associated with boda-boda accidents (Table 3). Other factors identified by the respondents include age of the boda-boda rider (58%) and drug use (56%) (Table 3). Thus, setting up of pick-up lines and punishment of individuals who over speed can reduce accidents associated with such factors.

**Table 3: Individual involvement in an accident and factors perceived to be associated**

Variable	Frequency (N=200)	Percentage (%)
Competition for passengers	166	83
Negligence of road safety rules	156	78
Inadequate helmet usage	124	62
Age of the boda-boda rider	116	58
Drug use	112	56
Ownership of the motor bicycle	46	23
Narrow roads	22	11

### Discussion

This study mainly reveals behavior related factors contributing to RTAs. Factors like competition for passengers are associated with over speeding by boda-boda riders. A study in Gulu municipality by (Pebalo et al., 2012) also pointed out over speeding by boda-boda riders. This competition for passengers is likely to increase chances of the motorcyclist paying less attention while riding thus increasing his vulnerability to accidents (Zhang et al., 2016). Negligence of road safety practices for instance use of helmets by boda-boda riders identified in this study can be attributed to the inadequate implementation of the existing road safety rules. Some studies like (Møller & Hels, 2008) have shown that motorcyclists have less knowledge of road safety rules. This is similar to this current study which indicates less trainings of the motorcyclists on road safety rules increasing their risk of being involved in accidents. Use of helmets by motorcyclists is known to reduce death and injury in the event of an accident (Gjerde et al., 2011). Studies by (Mittal, 2008) in India indicate that existing traffic rules without enforcement yield poor results. There is a positive correlation between drivers' risk perception and perception of driving tasks this affects drivers' road safety attitude (Ram & Chand, 2016). Risk perception partially mediates the relationship (Ram & Chand, 2016). Studies by (Dapilah et al., 2017) in Ghana indicate motorcycle related accidents to be highly associated with human

behaviors like consumption of alcohol and inadequate helmet usage. Inadequate use of helmets is also attributed to its high cost and discomfort amongst motorcyclist riders when they wear it (Dapilah et al., 2017). This study also indicates age to be the determining factor for accidents associated with boda-bodas similarly to results by (Mohan, 2009). (Mohan, 2009) in his studies in India indicate that age plays a key role in adherence to traffic regulations. Older persons often tend to follow traffic regulations compared to those at youthful age (Mohan, 2009). However, in similar studies on motorcycle related accidents studies, older drivers are vulnerable to accidents because of their poor eyesight (Akanbi et al., 2009). This contradiction could be because of the difference in the age groups that dominate boda-boda industry in different locations.

The huge gender difference with absence of women in the boda-boda business highlights the role of culture and norms in boda-boda business in Kampala. This study points out the need for holistic interventions to address such boda-boda accidents in Uganda. These interventions should be at personal and communal level. At personal level, passengers ought to select mentally sound and sober motorcyclists not those who appear to consume alcohol. The government of Uganda should prioritize constructing lanes for motorcyclists. Interventions should strategically be designed considering age and gender among other attributes.

More large scale studies should also be done to unravel complexity of factors associated with boda-boda accidents.

### **Limitations to the study**

Language barrier was a problem during data collection but it was addressed through use of translators. Also, inadequate participation by some members was registered as they were already conducting their business during the survey. This was however addressed through explaining the importance of the study to the respondents.

### **Acknowledgement**

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**Appendix**

The questionnaire used for assessing perceived risk of road traffic accidents involving boda-boda riders in Kampala, Uganda is as follows.

**Section A**

(1) What is your age in complete years? . . . . .

(2) What is your gender?

1 = Male

2 = Female

(3) What is your tribe? . . . . .

(4) What is your religion?

1 = Catholic

2 = Protestant/Anglican

3 = Muslim

4 = Pentecostal

5 = SDA

6 = Other, specify . . . . .

(5) What is your level of education?

1 = Primary

2 = Secondary

3 = Advanced

4 = University

**Section B**

(6) Do you perceive yourself to be at risk of accidents?

1 = Yes

2 = No

(7) If yes, how do you rate your risk of being involved in an accident?

1 = High

2 = Moderate

3 = Low

(8) Do you have an helmet now?

1 = Yes

2 = No

(9) Have you been using an helmet for the past 6 months?

1 = Yes

2 = No

(10) Do you know any other boda-boda rider who was involved in an accident?

1 = Yes

2 = No

(11) If yes, does that make you think you are at risk of road traffic accident?

1 = Yes

2 = No

(12) For the past one week, did you ever take alcohol before riding?

1 = Yes

2 = No

(13) If yes, does that make you think that you are at risk of accidents?

1 = Yes

2 = No

(14) Have you ever competed for passengers with other transport operators?

1 = Yes

2 = No

(15) If yes, does this make you think you are at risk of accidents?

1 = Yes

2 = No

(16) Have you ever attended trainings for road safety rules?

1 = No

2 = Yes

(17) If yes, at does that make you feel you are at risk of road traffic accidents?

1 = Yes

2 = No

(18) Have you been involved in accident for the past 12 months?

1 = Yes

2 = No

(19) If yes, did were you wearing an helmet?

1 = Yes

2 = No

(20) Do you drink alcohol?

1 = Yes

2 = No

(21) If yes, have you ever driven when you have taken alcohol?

1 = Yes

2 = No

(22) Have you ever engaged in sex in exchange for money/gifts?

1 = Yes

2 = No

(23) What other factors do you think puts you at risk of road traffic accidents?

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## Offence and Crash Involvement of High-Frequency, High-Risk Offenders

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### Abstract

There is a high-frequency, high-risk offender group that is a high road safety risk and large economic burden on the Victorian community. This group continues to commit offences regularly, despite incurring demerit points, driving bans, court appearances, imprisonments, vehicle impoundments and crash involvements. Therefore, inducting this group into some form of countermeasure program could curtail their offending and risk-taking and thus reduce road trauma, and the economic cost of operating Victoria's traffic enforcement, justice and licensing administration systems. An earlier study developed a method of identifying this group of offenders, and the current study aimed to reselect a more up to date cohort and understand their characteristics during selection and follow-up periods. The current study also aimed to determine how many crashes and other events such as offences could be saved by a highly effective countermeasure program designed especially for this offender group.

### Background

There is a small minority of drivers who commit multiple offences, present an on-going risk to themselves and other road users and whose behaviour is not managed effectively by the current sanctions regime. They commit numerous offences, accumulating many fines, demerit points and driving bans. These drivers are a substantial problem for enforcement and road safety agencies and hence need to be effectively identified, understood and managed.

In 2017, a method of identifying this high-risk offender group was developed and undertaken. The best definition of a high-frequency, high-risk offender that identified 4,567 offenders (0.089% of the active driving population<sup>1</sup>) based on a two-year selection period was:

“A driver who has been convicted of at least 12 traffic offences and has incurred a driving ban and/or been sentenced to a term of imprisonment as a result of an offence committed during that period.” (Catchpole, 2017, page iii)

### Aim

The present study aimed to select a new cohort of these offenders and determine the number of crashes and offences that may have been prevented if a hypothetical totally effective countermeasure program had been applied to the selected drivers (Naznin & Catchpole, 2019). (Road Safety Victoria [RSV] is investigating countermeasures tailored to these high-risk drivers separate to this research.)

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<sup>1</sup> Some high-risk offenders do not hold a driver licence or permit. To ensure no high-risk offenders were unintentionally excluded, it was necessary to adopt a very broad definition of the active driving population. Drivers were excluded as inactive if they were known to have died. Drivers to whom a licence or permit had been issued (including those whose licence had been suspended, cancelled or disqualified) were excluded as inactive if they had no recorded activity (licence renewal, address change, offence conviction, driving ban, change of licence status, etc.) in the last 10 years. Drivers to whom no licence or permit had ever been issued were excluded if they had no recorded activity in the last five years. Those whose licence was suspended or expired were excluded if they had no recorded activity in the last 12 months.

## Method

Using the Victorian Driver Licensing System (DLS), the high-risk offender cohort was identified using the above definition using the selection period July 2014 to mid-August 2016. The subsequent involvement of the group in crashes, offences and penalties was assessed for a follow-up period October 2016 to September 2017.

The DLS provided information about traffic offences, driving bans, good behaviour bonds and sentences of imprisonment. Victoria's Road Crash Information System provided information about casualty crashes. Records of vehicle impoundments as a result of offence involvements were supplied by Victoria Police.

## Results

The new high-risk offender cohort comprised 4,384 drivers or 0.087% of the active driving population in August 2016. During the selection period, this group was over-represented (compared with the active driving population was over-represented) in:

- casualty crashes - 7.6 times
- fatal and serious injury (FSI) crashes - 9.6 times
- driving bans - 178 times
- vehicle impoundments - 186 times
- court-imposed good behaviour bonds - 101 times
- sentences of imprisonment - 370 times.

The selected drivers had a lower rate of crashes, offences and related penalties during the follow-up period than during the selection period; however, they were still markedly over-represented by comparison with the entire active driving population:

- casualty crashes - 2.9 times
- FSI crashes - 4.8 times
- offences - 11 times.

If a hypothetical 100% effective countermeasure program had been applied to the 4384 drivers identified, 55 casualty crash involvements (including 32 FSI crash involvements), 70 casualties, 14,262 offences, 610 vehicle impoundments, 2,807 driving bans and hundreds of court appearances would have been saved during the 12-month follow-up period. The benefits from reduced death and serious injuries on Victorian roads would also result in economic, health and social benefits to Government and the community. The focus of the project was to undertake analysis of data to try to identify drivers who posed a serious road safety risk as a means for further work in identifying evidence-based countermeasures. The ability to identify this high-risk cohort of drivers means RSV can triage offenders into more individual centred appropriate interventions and programs to address their underlying offending motivations and behaviours. RSV and its road safety partners will continue to work together to develop evidence-based approaches to better manage high risk frequent offenders.

## Conclusion

The high-risk offender group identified poses a high crash and offence risk to themselves and the road user community. Even though they are a small group, it is expected if effective programs, including case management are put in place, this risk as well as high socioeconomic costs can be reduced. RSV is currently investigating these countermeasure possibilities.

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## Screening older drivers: The experiences of General Practitioners with medical fitness to drive assessments

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### Abstract

Highly-motorised countries have increasing numbers of ageing older drivers. In many of these jurisdictions, health practitioners are responsible for undertaking the screening of older drivers, via medical assessment of fitness to drive (FtD), to ascertain suitability to continue to hold a driver's licence. In New Zealand, all older drivers are required to have a medical FtD assessment at ages 75 years, 80 years and then biennially. This study used an interpretive description qualitative methodology to understand the FtD assessment process from the perspectives of ten general practitioners (GPs). The results indicate that GPs use FtD assessment as a way of staging a clinical conversation about mobility and driving cessation. The assessment process, however, challenges a patient-centric approach and can negatively impact relationships. This study also highlights several system issues encountered by GPs, limiting their capacity to provide best practice FtD assessments and mobility counselling for older adults.

### Background

New Zealand (NZ), like many westernised countries, has an ageing population dependent on driving. Being able to drive is often essential for carrying out activities of daily living, and supports psychological functions such as autonomy, protection and prestige [1, 2, 3]. Although older drivers have relatively few crashes, due to frailty they have high fatality rates [4], especially those aged 75<sup>+</sup> years [5]. In many jurisdictions, screening of older drivers, through the medical assessment of fitness to drive (FtD) is undertaken to ascertain suitability to continue to hold a driver's licence. Until December 2006, NZ drivers aged 80 and over were required to sit biennial on-road driving assessments to retain their driver's licences [6]. Current law requires drivers to renew their licences at ages 75, 80 and biennially thereafter, by obtaining a medical FtD certificate as part of the process. FtD assessments are primarily carried out by general practitioners (GPs), with mandatory medical reporting to the licensing agency. This study explored the experiences of NZ GPs with the medical assessment of FtD process for older people.

## Methods

Interpretive description qualitative methodology was used to guide the research design and data analysis [7]. GPs were purposively sampled and interviewed face-to-face, until saturation of themes was reached (N=10, 40% rural practitioners). The sample was considered final after a workshop with approximately 70 GPs at a NZ Conference [8] indicated that the themes derived from the study sample captured the main issues experienced by GPs in their practices.

## Results

Three interwoven concepts emerged from the analysis: navigation of transitions, maintaining relationships and system issues. The results indicate that GPs use the FtD assessment as a way of staging a clinical conversation about mobility and driving cessation while balancing public vs private good. However, reports of patients' 'doctor-shopping' indicates that the assessment process can impact on relationships with patients. GPs reported differences in use of tools, such as driving restrictions, to support patients near the end of their driving careers. Knowledge gaps and access issues reported by GPs were a substantive barrier to the use of specialist driving assessments.

## Conclusions

GPs carrying out medical FtD assessment in the clinical setting is problematic, but it continues to be used in many jurisdictions. The assessment process puts pressure on a patient-centred approach, giving rise to breakdowns in clinical relationships. This study also demonstrates a lack of training and support for GPs working with patients toward the end of their driving careers. A knowledge and information gap exists among GPs, limiting their capacity to provide best practice FtD assessments and mobility counselling for older adults.

In late 2018, the NZ law changed to allow qualified nurse practitioners and registered nurses to undertake FtD assessment. Given this law change, it is pertinent that the issues identified are addressed. Although broadening the categories of health practitioners who can issue certificates will alleviate some of the workload issues associated with the ongoing shortage of GPs, the systemic issues with the FtD assessment process will transfer to these practitioners, potentially without the benefit of continuity and in-depth knowledge of the patient history.

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# Effectiveness of Vehicle Impoundment for Victorian High Level Speeders

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## Abstract

Victoria Police have had the power to impound the vehicles of particular offenders since 2006 as part of “anti-hoon” laws. At this time impoundment lasted 48 hours (Stage 1), with three months for repeat offenders. In 2011 the impoundment laws were revised to allow 30 day (Stage 2) impoundment for a first offence. The two impoundment stages were investigated for effectiveness on speeding offending for high level speeders (who speed 45 km/h or more over the limit) as part of a wider project evaluating the effect of various sanctions on speeding drivers. The impoundment countermeasure was introduced after others, such as increased licence bans and demerit points. The results for both stages of impoundment were favourable and showed that impoundment reduced speeding re-offence rates. In addition, the impact of the licence ban was greater for those who experienced impoundment, indicating the value in both these sanctions in reducing high-level speeding.

## Background

Vehicle impoundment was introduced in the US approximately 25 years ago to address drink-driving and unlicensed driving (Centres for Disease Control and Prevention, 2015). Overseas evaluations show mixed results, with some US studies indicating a reduction in offending and crashes and others showing little impact. There were not any statistical evaluations of impoundment in Australia at the time of undertaking our evaluation of the Victorian impoundment sanction on high-level speeders (speeding 45 km/h or over the limit or 145+ km/h in a 110 km/h speed zone) (Watson et al., 2016). Therefore, this study was an important piece of research for Victorian Government road safety policies that address high-level speeding drivers.

Vehicle impoundment was introduced in Victoria for 48 hours in 2006 and then extended in 2011 to 30 days with offences that result in impoundment added. Victoria Police, at their discretion, can impound a vehicle if it was used to commit a relevant offence. Courts can also order vehicle impoundment for up to a maximum of 90 days (total police and court impoundment, usually given to repeat offenders). The relevant impoundable offences are high risk driving offences (e.g. drink-driving with a BAC of 0.1 or higher, unlicensed driving), dangerous driving offences (e.g. careless driving, failure to have proper control of a vehicle) or hoon driving offences (e.g. loss of traction, street racing). The VicRoads website has further information.<sup>1</sup>

This study examined the impact of both impoundment Stages (48 hours and 30 days) on speeding offence rates for high level speeders, as well as the effect of the licence ban (twelve months) with impoundment.

## Method

Data was extracted from the Victorian Driver Licensing System between 1 July 2006 and 31 December 2014. The analyses involved calculating speed offence (all speeding or speed-related dangerous driving offences) rates per 1,000 licence person-years and making comparisons using rate ratios (Siskind, 1996). Further statistical details are documented in Imberger, Watson & Kaye (2019).

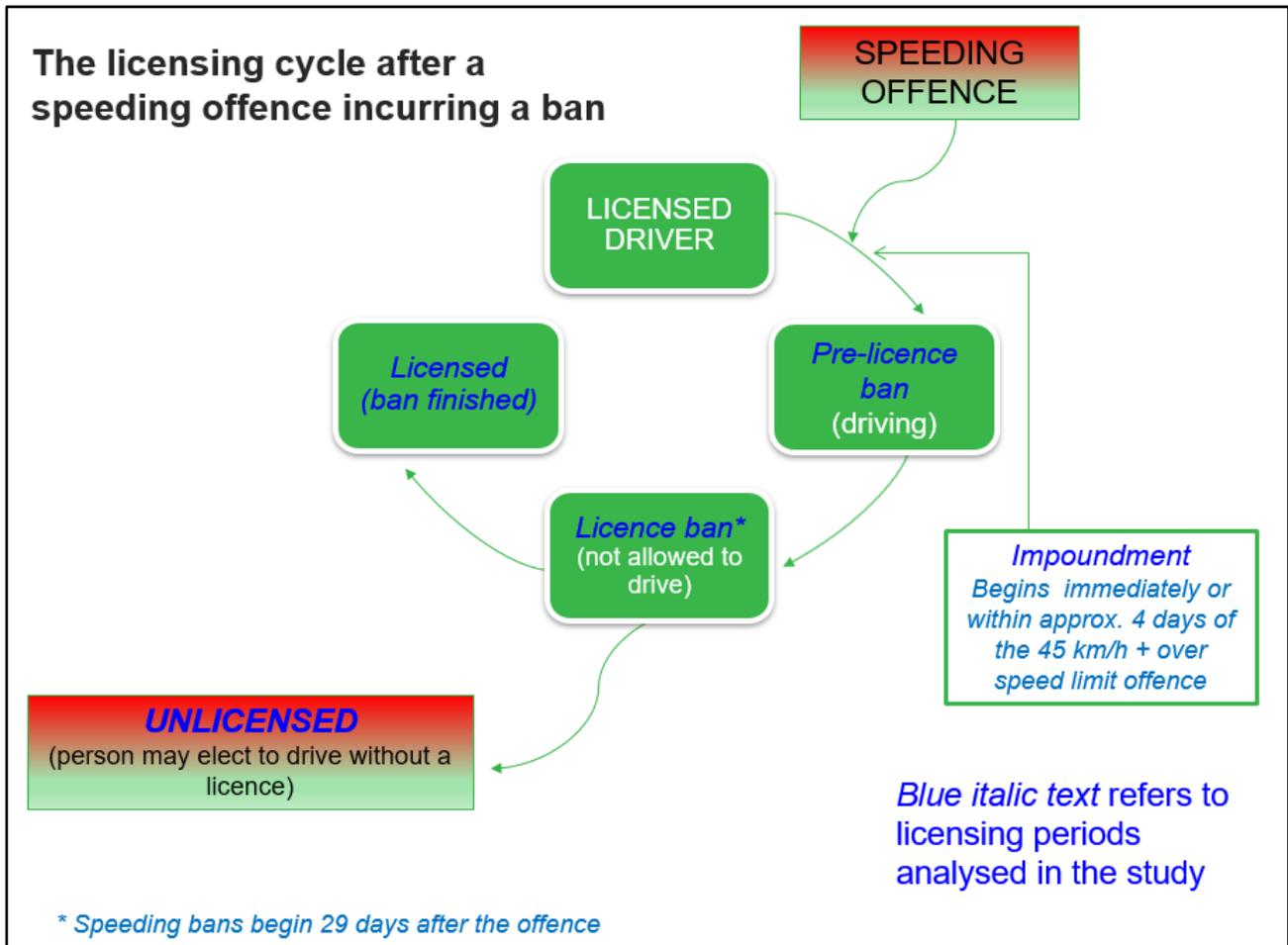
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<sup>1</sup> <https://www.vicroads.vic.gov.au/safety-and-road-rules/road-rules/penalties/vehicle-impoundment>

The first analysis examined speeding offence rates to determine the effectiveness of impoundment across these licensing cycle periods (Figure 1):

1. impoundment compared with pre-impoundment
2. licence ban compared with pre-licence ban
3. impoundment compared with licence ban
4. impoundment compared with licensed (ban finished)
5. licence ban compared with licensed (ban finished)
6. licensed (ban finished) compared with pre-licence ban.

The second analysis compared impoundment with no impoundment across licensing cycle periods 2, 5, 6 above and the licence ban compared with post-ban unlicensed.



**Figure 1. The licensing cycle indicating the licence periods for drivers who commit a high-level speeding offence**

**Results**

Impounded high level speeding offenders across both stages had lower speeding offence rates for all licence periods (except the period before detection) between 15% and 55%<sup>2</sup> lower compared with high level speeding offenders who did not have their vehicle impounded. As outlined in Table 1, for high level speeding offenders with impounded vehicles, there were lower rates of speeding offending during the:

<sup>2</sup> Lowest to highest results across both Stages.

- licence ban compared with the pre-licence ban (57% and 33% for Stage 1 and 2 respectively) and licensed (ban finished) periods (68% and 63% for Stage 1 and 2 respectively)
- licensed (ban finished) compared with the pre-licence ban (28% and 7% for Stage 1 and 2 respectively).

**Table 1. Effect of licensing cycle periods on high level speeding offences for high-level speeding offenders with impounded vehicles (Stage 1 and Stage 2)**

<b>Licensing period (bolded period is the period with the reduction or increase in offences/crashes)</b>	<b>High level speeding offences (Stage 1)</b>	<b>High level speeding offences (Stage 2)</b>
<b>Impoundment</b> compared with pre-impoundment	33% 	38% 
<b>Licence ban</b> compared with pre-licence ban	57% 	33% 
<b>Impoundment</b> compared with licence ban	55% 	79% 
<b>Impoundment</b> compared with licensed (ban finished)	51% 	34% 
<b>Licence ban</b> compared with licensed (ban finished)	68% 	63% 
<b>Licensed (ban finished)</b> compared with pre-licence ban	28% 	7% 

Note: All results are significant unless indicated (green arrows = decrease)

Stage 1 and Stage 2 high level speeding offenders who had their vehicles impounded compared with high level speeding offenders with non-impoundment had fewer speeding offences during a ban than the licensed (ban finished) period (42% and 47% less offending for impounded offenders than non-impounded respectively) (Table 2). Reported results are statistically significant. Note that for Stage 1 offenders with impoundment had a significant 17% higher speed offence rate than those without impoundment for the period before detection of index<sup>3</sup> offence (the same was found for Stage 2 - a significant 29% higher speed offence rate than those without impoundment for the period before

<sup>3</sup> An index offence was identified as the first ‘impoundment eligible’ excessive speed offence in the relevant stage.

detection of index offence). Regardless, Table 2 indicates that impoundment was effective for the indicated licensing cycle periods.

**Table 2. Effect of licensing cycle periods on high-level speeding offences with impounded and not impounded vehicles**

Licensing period (bolded period is the period with the reduction or increase in offences)	Stage 1 impoundment		Stage 2 impoundment	
	<i>Yes</i>	<i>No</i>	<i>Yes</i>	<i>No</i>
<b>Impounded</b>				
<b>Licence ban compared with pre-licence ban</b>	57% ↓ No difference between the impound and non-impound group	54% ↓ No difference between the impound and non-impound group	33% ↓ No difference between the impound and non-impound group	31% ↓ No difference between the impound and non-impound group
<b>Licence ban compared with licensed (ban finished)</b>	68% ↓ Impounded - 42% less offending than non-impounded	45% ↓ Impounded - 42% less offending than non-impounded	63% ↓ Impounded - 47% less offending than non-impounded	31% ↓ Impounded - 47% less offending than non-impounded
<b>Licensed (ban finished) compared with pre-licence ban/pre-impoundment</b>	28% ↓ Impounded - 15% less offending than non-impounded	16% ↓ Impounded - 15% less offending than non-impounded	7% ↓ No difference between the impound and non-impound	1% (not sig) ↓ No difference between the impound and non-impound
<b>Licence ban compared with post-ban unlicensed</b>	70% ↓ Impounded - 33% less offending than non-impounded	55% ↓ Impounded - 33% less offending than non-impounded	65% ↓ Impounded - 41% less offending than non-impounded	41% ↓ Impounded - 41% less offending than non-impounded

Note: All results are significant unless indicated (green arrows = decrease), percentage differences between impounded and non-impounded calculated from original rates (not percentages shown)

## Conclusion

The evaluation for both impoundment Stages was favourable. Impoundment was linked to reduced speeding re-offence rates and the impact of the licence ban was greater for those who experienced impoundment. Victoria Police impoundments for total “hoon” offences have increased each year since introduction (with high-level speeding 15% of the total). Continuing the countermeasure is justified in relation to high level speeding offenders.

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## Changes in Driving Performance after First and Second Eye Cataract Surgery: A Driving Simulator Study

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### Abstract

Driving is heavily dependent on vision. Whilst self-reported driving-related difficulties reduce after cataract surgery, less is known about the impact of cataract surgery on objective driving performance measures. This study recruited patients with bilateral cataract from three public hospital ophthalmology clinics in Western Australia to investigate changes in driving performance as measured by a driving simulator. Participants completed a research-administered questionnaire, a cognitive assessment, three visual tests and a driving simulator assessment before and after first and second eye surgery. After adjusting for potential confounders, the number of crashes/near misses decreased after both first and second eye cataract surgery, whilst the amount of time speeding only reduced after second eye surgery. As binocular contrast sensitivity improved, the risk of crashes/near misses and the amount to time speeding were reduced. These findings support the importance of timely first and second eye cataract surgery for cataract patients.

### Background

Cataract is a leading cause of visual impairment worldwide with an estimated prevalence of 75% by age 80 (Australian Institute of Health and Welfare, 2005) It is usually treated with cataract surgery, routinely performed on each eye separately. However wait time between first and second eye surgery can be between six months to a year in the Australian public health system (Australian Institute of Health and Welfare, 2010), resulting in patients driving for extended periods between surgeries. Although Subzwari et al. found that cataract surgery decreased the risk of self-reported driving-related difficulties by 88% (Subzwari et al., 2008), less is known about the impact that cataract surgery may have on objective driving measures. Therefore, this study aimed to investigate the impact of first eye and second eye cataract surgery on changes in driving performance measured by a simulator.

### Method

A prospective cohort study of older adults with bilateral cataract awaiting first eye cataract surgery from three public hospital ophthalmology clinics in Perth, Western Australia was undertaken from December 2014 to February 2017. Information was collected before first eye surgery, after first eye surgery and after second eye surgery. Participants completed a researcher-administered questionnaire about socio-demographic characteristics, the Driving Habits Questionnaire (Owsley, Stalvey, Wells & Sloane, 1999), the Mini-Mental State Examination (Folstein, Folstein & McHugh, 1975), three objective visual tests (visual acuity, contrast sensitivity and stereopsis) and a driving simulator assessment. The simulated driving scenario consisted of a three-dimensional model, which represented approximately ten kilometers (km) of generic WA road in the metropolitan area, during the daytime and took approximately 10 minutes to complete. The simulator scenario required drivers to negotiate two give way signs (one left, one right turn), one stop sign (continue straight), one merge, three uncontrolled intersections (one left, two right turns), five sets of traffic lights (two right, one left turn and two continue straight) and five roundabouts (two right turns and three continue straight). Driving exposure was collected via an in-vehicle driver-monitoring device. Outcomes of interest from

the driving simulator included: speed limit compliance, speed variation, lane excursions, and number of crashes/near misses. Near misses were defined as any circumstance that required a rapid evasive maneuver by the driver to avoid a crash. A crash was defined as any physical contact between the subject vehicle and another vehicle, fixed object or pedestrian. Separate Generalized Estimating Equation (GEE) Poisson or linear regression models were undertaken to examine changes in driving simulator performance after accounting for visual, demographic, years driving and weekly driving exposure.

## Results and Conclusion

Forty-four participants completed all three driving simulator assessments comprising a total of 132 observations.

The mean age of participants before first eye cataract surgery was 73.2 years (SD=8.3) with a range from 56 to 88 years. Most participants were male (n=23, 52.3%).

The results from the GEE Poisson regression model found that risk of crashes/near misses decreased by 36% after first eye surgery (p=0.01) and by 47% after second eye surgery (p<0.001) after adjusting for confounders. As contrast sensitivity improved, risk of crashes/near misses decreased by 10% (p=0.043). Males had 2.1 times the risk of crashes/near misses compared to females (p=0.002), and unemployed drivers had 1.8 times the risk compared to employed drivers (p=0.045). As driving exposure (km/week) increased, the risk of crashes/near misses decreased by 10%.

The results from GEE linear regression model found that time speeding after second eye surgery was 0.14 minutes (p=0.002) less after second eye surgery, compared to before first eye surgery, after accounting for confounders. As contrast sensitivity improved, speeding reduced by 0.46 minutes (p=0.038). Males spent more time (0.62 minutes) speeding compared to females (p=0.003), whilst those aged 70+ spent less time (0.51 minutes) speeding compared to those aged 55-69 (p=0.030)

These results highlight the importance of timely first and second eye cataract surgery for drivers with bilateral cataract, even for those with lower levels of visual impairment. It may also raise awareness of the impact that cataract and cataract surgery may have on driving performance and road safety.

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**Table 1. GEE Poisson/linear regression model of the impact of first and second eye cataract surgery on number of crashes/ near misses and speed non-compliance in the driving simulator (n=44)**

<b>Crashes/Near Misses</b>				
<b>Variable</b>	<b>IRR</b>	<b>95% CI</b>		<b>P-Value</b>
<b>Cataract Surgery</b>				
Before first eye surgery	1.00			
After first eye surgery	0.64	0.47	0.88	0.01
After second eye surgery	0.53	0.35	0.78	<0.001
<b>Gender</b>				
Female	1.00			
Male	2.12	1.43	3.14	0.002
<b>Employment</b>				
Employed/Non-retired	1.00			
Unemployed/retired	1.77	1.04	3.03	0.045
<b>Contrast Sensitivity<sup>†</sup> (log units)</b>	0.69	0.48	0.90	0.041
<b>Driving exposure (km/ week)</b>	0.90	0.90	0.91	0.043
<b>Speed non-compliance*</b>				
<b>Variable</b>	<b>Parameter Estimate</b>	<b>95% CI</b>		<b>P-Value</b>
<b>Cataract Surgery</b>				
Before first eye surgery (reference)				
After first eye surgery	-0.04	-0.25	0.18	0.426
After second eye surgery	-0.14	-0.30	-0.02	0.002
<b>Gender</b>				
Female (reference)				
Male	0.62	0.23	0.89	0.003
<b>Age Group</b>				
55-69 years (reference)				
70+ years	-0.51	-0.89	-0.12	0.030
<b>Contrast Sensitivity<sup>‡</sup> (log units)</b>	-0.46	-0.87	-0.06	0.038

GEE: Generalized Estimated Equations, IRR: Incidence rate ratio, CI: confidence interval  
<sup>†</sup> Contrast sensitivity measured with both eyes  
\* Minutes spent  $\geq$  10km/h over the speed limit  
<sup>‡</sup> Contrast sensitivity measured with both eyes

## Traffic Analysis – AI from a bird's eye view

Aimee Wescombe

GHD

### Abstract

Traditional methods of traffic data collection are primarily limited to vehicle data collection only, or requires labor intensive manual observations that can be prone to error. To provide a complete and comprehensive understating of how an intersection, the collection of aerial imagery is used to survey a traffic scene. This enables the observation of the behavior and interaction of all road users, including pedestrians and bike riders. This footage is processed using artificial intelligence, which assigns user classifications, determines interaction between users, and calculates turning movements. Further information is collected on origin destination, traffic behavior and desire lines. The data collected is analysed to determine critical safety operation, including time to collision and post encroachment time. Traffic behavior can be determined by analysing dwell time, evasive behavior and signalised intersection compliance. Understanding the fundamental interaction between road users allows practitioners to improve road spaces to align with safe system principles.

### Background

The use of artificial intelligence and machine learning provides a comprehensive analysis of the operation of existing intersections, particularly where there are many complex attributes such as high number of conflict points, user classes and high traffic volumes.

The study undertaken focused on the signalised intersection of Holden Street and St Georges Road, Fitzroy North. The site has a history of near misses and crashes, illegal turning maneuvers and moving against The study aims to understand how the operational performance of trams is affected by passenger loading, road network demands and incidents.

A drone was piloted from a nearby site, collecting extended aerial video footage of the intersection during morning and evening peak periods. During these times, the intersection is subject to road user classifications of: pedestrians, bike riders, trams, general traffic, commercial vehicles and heavy vehicles.

The AI processing of the footage identified every single road user, assigning a unique ID and user classification. The AI tracks each user from the moment they enter the scene (video footage), to the moment they leave. Throughout the scene, a vector is applied to each user at 40 millisecond intervals. Applying algorithms to these vectors provides the information of where a road user is in the scene at any time, as well as acceleration and deceleration.

Using this information, the following was determined at the intersection:

- **Vehicle speeds at intersections.** Used to determine acceleration and deceleration through an intersection. By isolating vehicles by classification, a detailed understanding of road behaviour is developed. This information showed that whilst there was generally compliance by motor vehicles, there was frequently high speed late arrivals to the site, exposing opposing turning vehicles to conflict within the intersection.

- **Safety and Near Misses** This analysis enables us to calculate gap analysis, PET and TTC. These measures inform us of the risks drivers are taking when manoeuvring through an intersection. The study found that the sequence of the signal phasing put pedestrians and cyclists at high risk, with frequent near misses between right turning traffic, opposing trams and green pedestrian phase.
- **Pedestrians and Cyclist.** The ability to track all road users through a subject site, including pedestrians and cyclists, enables us for the first time to provide facts behind road user behaviour. Through this study, pedestrian desire lines were found to cross throughout the intersection away from the crosswalk lines as pedestrians attempt to access the tram stop before the approaching trams pause at the tram stops. This demonstrates that the existing intersection configuration and traffic signal configuration does not provide adequate accessibility. As a result, pedestrians often jay walk, and are at risk from other road users.

The AI processing of traffic movements provided detailed understanding of traffic interaction, compliance and operation safety. It is evident that competing demands and traffic congestion at the site lead to risk taking and non-compliance by different user groups, putting other road users at risk of injury. This information can be used to guide localised safety improvements as well as learnings for this typology of intersection.

## Definitions and associated factors of headway: A systematic review of passenger vehicle studies

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### Abstract

Unsafe headway or driving too close to the lead vehicle in a moving traffic risks rear end crashes; a leading crash type in Australia. This review aimed to systematically review headway definitions and associated factors in light passenger vehicle studies published between 1980-2020. Of 5442 articles identified, 110 were retained. Only 49.6% defined headway sufficiently for reproducibility. Nine broad domains of associated factors were observed: speed, lead vehicle type, traffic condition, road characteristics, task engagement, driving under influence, weather, demographics, and safety alert system that affect headway. Improving definitions and addressing these domains is necessary to reduce rear end crashes.

### Background

Headway is best defined as the gap between the rear of the leading vehicle and front of the following vehicle (Biswas et al., 2020). It can be measured as a unit of time (usually seconds) or distance (usually metres) (Bella et al., 2014; Risto & Martens, 2013).

Between 2015-2019, nearly one-quarter (23.9%, 81,589) of all crashes in New South Wales (NSW) were rear end. While these crashes led to comparatively few fatalities (N = 78, 0.01%) (NSW Centre for Road Safety, 2020), many resulted in long-term health problems, for example, 45% of all Compulsory Third Party claims in NSW for 2009 was for whiplash injuries, typically caused by rear end crashes (Anderson & Baldock, 2008). To reduce the prevalence of rear end crashes, a detailed understanding of headway and why drivers drive too close is necessary.

Headway is considered an indicator of driver performance, reflecting attention to the traffic ahead and gap acceptance or preference. Short unsafe headways reduce drivers' time to respond (e.g., braking or swerving), increasing rear end crash risks (Jamson et al., 2005).

This review focused on articles that assessed headway in light passenger vehicles, where driver behaviour and related environmental factors were analysed to explore potential risk factors for unsafe headways. The objective was to systematically review definitions of headway used in literature and factors associated with safe and unsafe headways to make recommendations to increase safer driver behaviour and performance through a qualitative analysis.

### Method

The review followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009). Four databases (EMBASE, COMPENDEX, SCOPUS, MEDLINE) were searched on 26/09/2018 and updated on 15/07/2020 using search terms (vehicl\* AND safe\*) AND (tailgat\* OR headway\* OR ``car\* follow\*" OR platoon\* OR ``vehicl\* follow\*" OR ``time-to-collision") for English-language publications since 1980. From 5442 results, duplicate and irrelevant articles were removed leaving 1029 unique abstracts.

Abstracts were reviewed by two study authors (RKB, RF) and retained when headway was a predictor or outcome variable in studies of drivers of light passenger vehicles in moving traffic on roads or in

a simulator. Half the documents (52%) were excluded because headway was not analysed as a behavioural factor and several others (23%) as they focused on methods of traffic flow models only. 200 articles were thus identified for independent full-text review. Authors initially agreed on 96.5% (193/200) of inclusions and reached consensus on the rest, yielding 110 unique articles for qualitative synthesis.

## Results

A qualitative synthesis found considerable inconsistency in headway definitions and measurements. Half of the reviewed studies failed to clearly define headway (50.4%) and one-third (34 out of 110) did not include any definition. Headway should be a precise measure with comparability across studies, but the definitions reviewed indicate two major issues: different reference points (e.g., bumper/axle/rear) are used for headway measures and inconsistent measuring techniques of vehicle length are used in headway calculation.

From the full text review, factors associated with changes in headway in moving traffic were documented and categorised into nine domains (Table 1).

*Table 1: Summary of the factors documented to be associated with headway in literature.*

Factor associated with headway	Number of studies*	Headway measuring method	Overall findings
Speed	6	3 on-vehicles, 2 simulations and 1 road-side feature.	The association between speed and headway varied across data collection methods. Data collected from a single point observation suggested greater speeding led to short headways whereas continuous observation from multiple instrumented vehicles indicated median speed tended to increase with higher speed, while simulation studies yielded no associations.
Traffic condition	6	1 on-vehicle, 2 simulations, and 3 road-side features.	Headway reduced when there was a traffic flow from the opposite direction or when passing through work zones.
Road characteristics	14	4 on-vehicles, 2 on-roads, 3 simulations, and 5 road-side features	Road markings could reduce headway by visually influencing drivers' perception of distance. Drivers tended to imitate other traffic and adapt headway according to the type and shape of the roadways. Inconsistency was observed for road types and even with large samples, conclusive results were not reported.
Secondary task engagement	22	3 on-vehicles, 15 simulations, 2 road-side features, and 2 reviews	Drivers tended to increase headway and decrease speed as they adapted to extra cognitive tasks but did not consistently increase safety margins during manoeuvres.
Driving under influence	3	1 on-vehicle, and 2 simulations	Driving performance deteriorated in all three investigations. Drug use or fatigued drivers tended to drive closer to the lead vehicle, but no direct association was found between headway and alcohol use.

Weather and visibility condition	13	3 on-vehicles, 1 on-road, 6 simulations, 2 road-side features and 1 mixed (road-side feature and on-road).	Adverse conditions, such as weather, time or temperature inside the vehicle, usually required drivers to adapt safer driving and increase headway.
Demography	16	5 on-vehicles, 3 on-road, 5 simulations, and 3 mixed (road-side feature, simulation, and on-road).	Higher headway inconsistency was observed for old drivers compared to young drivers, but older drivers kept larger headway. Novice drivers seemed to drive with shorter headway and less variation.

\*Some studies were included to assess safe headway threshold, which are not included in the table.

## Conclusions

Despite driver headway being clearly defined in the engineering literature, studies of headway in light vehicles showed very little consensus in how headway is defined and measured. This needs to be improved. Systematic review of the factors likely to influence headway reveal some likely targets for interventions to encourage safe headway.

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## **E-Scooters – are they last mile solution or the last mile health problem?**

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### **Abstract**

The "Last mile Problem" describes the difficulty in getting people from a transportation hub including railway stations, bus depots and train stations to their final destination. Micro-mobility devices including two wheeled motorised devices such as e-bikes, e-scooters, e-skateboards and Segways are considered a solution to the 'last mile transport' problem and are becoming increasingly popular globally. In September 2017, e-scooter company 'Bird' launched its first scooter sharing service in Santa Monica. Since then it has grown to over 100 cities and facilitated over 10 million rides<sup>i</sup>. Various other companies have launched e-scooter ride share initiatives around the globe. Findings of this review indicate that there was a sudden increase in presentations to the emergency department following the launch of shared e-scooters.

### **Background**

Globally, cities have rapidly expanding populations and increased urban sprawl causing increased problems with traffic congestion, pollution and inadequate transport options. E-scooters are considered a solution as they increase access to public transport, reduce private vehicle use, reduce emissions and are cost effective. Various e-scooter sharing services have launched in cities worldwide. This review aims to assess the impact on the public health system of shared e-scooters related trauma trends.

### **Method**

Literature reporting emergency department presentations after the introduction of e-scooter ride share services were reviewed. South Korea's reported on private e-scooter injuries. All research papers were retrospective reviews of medical data from hospitals, except Auckland's research using accident compensation claims data.

### **Results**

An inter-jurisdictional comparison of hospital data from e-scooter crashes was completed (Table 1). 60% were male. Mean age ranged from 30.4 to 37.1 years. A massive 85% of injuries were from falling off, in Auckland, this was 90%. The most common injury types were lacerations/abrasions and fractures. The most common injury locations were head, neck and upper extremities. Around 87% were discharged home. All studies reported patients with severe head trauma. 80% of studies recorded helmet use as low in jurisdictions lacking compulsory helmet use. An average of 22% had consumed alcohol prior to the e-scooter injury, however Brisbane findings indicated that alcohol presence did not increase the incidence of admissions. The Brisbane and Auckland studies included costs, \$32,108 in two months and \$603,843 in seven months respectively.

### **Limitations**

The South Korean study was the only one that included information about the time, day of week and location of the e-scooter incident. This study also included other personal mobility devices. No studies included information about speed of devices or infrastructure involved. Only the US study recorded if patients had drugs in their system at the time of admission. Only two studies reported on the cost of the trauma.

**Table 1. Overview of Research Papers**

Variable	Options	South Korean Study (Kim, 2018)	Auckland (Bekhit, 2019)	Southern California (Trivedi, 2019)	Brisbane (Tsao, 2019)	USA (Kobayashi, 2019)
Time Period		Jan 2016 to Dec 2017	20 Sep 2018 to 20 Apr 2019	1 Sep 2017 to 31 Aug 2018	23 Nov 2018 to 23 Jan 2019	1 Sep 2017 to 31 Oct 2018
Number of patients						
	Hospital	65	226	249	54	103
	Primary Care	Excluded	524	Excluded	Excluded	Excluded
Gender						
	Male	70%	56%	58%	52%	65%
	Female	30%	44%	42%	48%	35%
Age		Mean age 30.4, 50 adults, 15 pediatric	Mean age 32.1 (SD 13.7 years)	Mean age 33.7 (SD 15.3 years)	39% Aged 25-35	Mean age 37.1 (SD 11.9 years)
Road User						
	E-Scooter Rider	75%	99%	92%	98%	Not recorded
	Other PMD	25%	Excluded	Excluded	Excluded	Not recorded
	Pedestrian (Non-rider)	Excluded	1%	8%	2%	Not recorded
Mechanism of Injury						
	Falling/no collision	86%	90%	80%	Not recorded	Not recorded
	Collision with moving vehicle	14%	1.60%	9%	Not recorded	Not recorded
	Collision with object	Not recorded	Not recorded	11%	Not recorded	Not recorded
Location of incident						
	Sidewalk	25%	Not recorded	Not recorded	Not recorded	Not recorded
	Street	23%	Not recorded	Not recorded	Not recorded	Not recorded
	Alley	23%	Not recorded	Not recorded	Not recorded	Not recorded
Time of Injury						
	Late afternoon/Evening	38.50%	Not recorded	56%	Not recorded	Not recorded
	Daytime	26%	Not recorded	Not recorded	Not recorded	Not recorded
DOW of Injury						
	Saturday	26%	Not recorded	Not recorded	Not recorded	Not recorded
	Sunday	18.50%	Not recorded	Not recorded	Not recorded	Not recorded
Type of Injury						
	Laceration/ abrasion	68%	39% (Hospital data)	28%	59%	Not recorded
	Fracture	48%	29% (Hospital data)	32%	30%	42%
	Sprain /Soft Tissue	44%	24% (Hospital data)	Not recorded	17%	Not recorded
	Head Injury	Not recorded	Not recorded	40%	19%	18% Intracranial hemorrhage
Location of Injury						
	Head and Neck	68%	35% (Hospital data)	40%	19%	Not recorded
	Upper Extremity	46%	38% (Hospital data)	19%	65%	Not recorded
	Lower Extremity	34%	Not recorded	Not recorded	28%	Not recorded
Disposition from ED						
	% Discharged from Hospital ED	80%	70% (Hospital data)	94%	87%	86%
	Admitted to Hospital	13 patients admitted	30% (Hospital data)	6%	13%	14%
	Operative Management	7 patients - 3 severe head trauma	20% (Hospital data)	2 patients severe head trauma	6 patients	8 Patients ICU
Other Factors						
	Alcohol consumption	9%	27% (Hospital data)	5%	27%	48%
	Drugs	Not recorded	Not recorded	Not recorded	Not recorded	52% THC
	Helmet worn (where status known)	3%	Not recorded	11%	46%	2%
Increase		Injuries from personal mobility devices quadrupled in 5 years.	2 injuries per week to 35 a week	Not recorded	Pre ride share -1 incident a month, ride share 29 a month	A strong upward trend in admissions over time was confirmed using Spearman's correlation
Cost		Not recorded	\$603,843 (Hospital) \$1,303,155 (Hospital and Primary Care)	Not recorded	\$32,108	Not recorded
Injury Rate		Not recorded	20 per 100,000 (hospital data)	Not recorded	23 per 10,000	Not recorded

## Conclusion

The introduction of ride share e-scooters coincided in a significant increase in emergency visits in multiple jurisdictions. In the South Korean study, e-scooter trauma had quadrupled in five years based on private use alone. Several cases of severe head trauma were reported in all studies, which was associated with no helmet being worn. Falling from e-scooters was prominent however little is known about specific circumstances. Lime admitted that a glitch had caused an unknown number of e-scooters in its New Zealand fleet to randomly brake mid-ride, sending passengers flying. <sup>ii</sup> No studies focussed on other crash factors including speed of device, infrastructure or location of incidents. Future qualitative research is required to inform policy and regulation of e-scooters. Other jurisdictions reported up to a 17.5 fold increase in trauma with the introduction of e-scooter ride share programs. If e-scooters rideshare programs were to be trialled in Victoria, a similar increase in trauma would be expected, with a significant cost to the public health system.

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## Evaluate travel speeds and associated risk of casualty crashes through intersections in Australia using naturalistic driving data

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### Abstract

Numerous crashes occur at intersections due to their inherent nature of creating potential points of conflict between traffic flows from different directions. To minimise the risk of casualty crashes, intersection designs should mitigate travel speeds within safe energy levels. This study aims to identify speeds and associated casualty risks of Australian drivers when travelling through some of the most common types of intersections.

Speeds of vehicles travelling in free-flow fashion through 93 intersections were extracted from the dataset of the Australian Naturalistic Driving Study (ANDS). Potential correlation of average and 85<sup>th</sup>-percentile speeds with intersection design characteristics was investigated. The risk of casualty crashes was assessed based on average speed and expected impact angles for each type of intersections.

Of all the types of intersections considered, roundabouts are characterised by the lowest average and 85<sup>th</sup>-percentile travel speeds, and the only design with average speeds resulting in a casualty risk below 10%.

### Background

Traffic from different directions intersects at road junctions, resulting in various potential points of conflict between crossing vehicles. In Australia and New Zealand, intersection crashes account for approximately 30% of fatal and serious injuries (Jurewicz et al, 2017). Given the known link between the risk of casualty in a crash and impact speed (Jurewicz, 2015), intersection designs should aim at mitigating travel speeds so that the potential impact speed is within a safe tolerance. This study aimed to identify the speeds, and associated risk of casualty crash, for drivers travelling through the three major intersection types used in Australia - signalised, priority and roundabout.

### Method

The speed of vehicles travelling in a free-flow fashion through 93 sampled intersections in the Sydney metropolitan area was extracted from the dataset of the Australian Naturalistic Driving Study (ANDS) (Williamson et al., 2015). Free-flow driving conditions were identified using information from the vehicles' front radar. Only intersections with at least five eligible trips were considered.

A univariate analysis of variance was used to investigate potential correlations between the average and 85<sup>th</sup>-percentile travel speeds and various intersection design characteristics such as (a) intersection type, (b) speed limit, (c) number of lanes, (d) lane width and (e) control line distance.

Finally, the risk of casualty crashes expected for any of the three considered intersection types was assessed using the X-KEMM-X approach (Jurewicz and Sobhani, 2016), based on the identified travel speed and assumed impact angles for each type of intersections.

## Results

The average and 85<sup>th</sup>-percentile speeds for each intersection types as well as results of the univariate analysis for each considered intersection design variables are shown in Table 1. The analysis indicated that:

- Travel speeds at roundabouts are considerably lower than at signalised and priority intersections
- Intersection type is the main design parameter to have a statistically significant influence on driver speed behaviour
- Other investigated design variables (speed limit, number of lanes, and lane width) are statistically significant only when considering all intersections types, but become insignificant when considering each intersection type separately

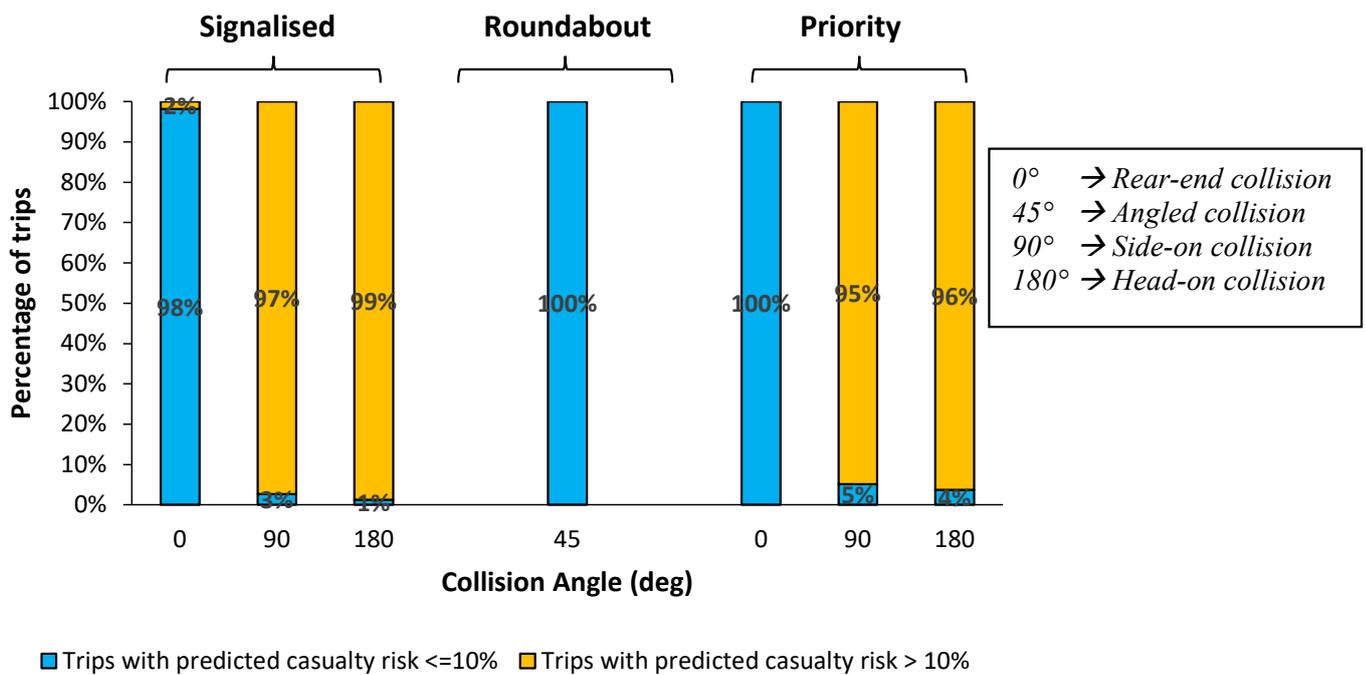
**Table 1. Speeds values and results of analysis of variance for each investigated design parameter and intersection types**

<i>Descriptive Statistics</i>								
	Mean Speed (km/h) <sup>(1)</sup>	Standard dev. (km/h)	85th %-tile Speed (km/h) <sup>(2)</sup>	Standard dev. of 85th %-tile Speed (km/h)				
Roundabout	29.1	3.2	32.9	4.2				
Signalised	46.6	5.2	54.4	6.4				
Priority	44.4	8.3	50.7	6.7				
<i>Analysis of Variance</i>								
	Any control types		Signalised ONLY		Priority ONLY		Roundabouts ONLY	
	p-value	Power	p-value	Power	p-value	Power	p-value	Power
Intersection type	< 0.05	1	-	-	-	-	-	-
Speed limit	< 0.05	0.999	0.25	0.34	0.55	0.14	N/A	N/A
Number of lanes	< 0.05	1	0.13	0.41	0.16	0.28	N/A	N/A
Lane Width	< 0.05	0.934	0.67	0.30	N/A	N/A	0.10	0.57
Control line distance	0.22	0.615	0.30	0.29	N/A	N/A	0.96	0.08

<sup>(1)</sup> Average of the mean speeds for aggregated trips at each sampled intersection

<sup>(2)</sup> Average of the 85<sup>th</sup>-percentile speeds for trips at each sampled intersection

The predicted level of casualty risk for each of the collision angles associated with the three considered intersection types is shown in Figure 1. Roundabouts are the only type of intersection with only a small proportion of trips exceeding a set threshold risk of 10%.



**Figure 1. Percentage of trips exceeding a 10% casualty risk (grouped by collision angles and intersection types).**

### Conclusions

Based on the considered sample of intersections in Sydney, roundabouts appear to be the only common type of intersection design capable of guaranteeing a low level of casualty risk. Since this investigation was based on speed data collected during a naturalistic study, results are expected to provide a good indication of the safety level of current common intersection designs in Australian metropolitan areas. Future investigations should consider a larger sample of intersections as well as the potential role of the driver specific psychological and physical profile in the analysis of the speeding behaviour.

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## Road Safety Innovation for Heavy Truck Movements Across Structures

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<sup>a</sup>Transurban, <sup>b</sup>Transurban, <sup>c</sup>Transurban

### Abstract

Transurban operates managed motorways, including Melbourne's CityLink, which connects to public motorways in the north, south and west of the city. CityLink is divided into two sections, the north-south leg known as the Western Link and the east-west leg known as the Southern Link.

As part of Victoria's current 'Big Build', construction resources such as heavy steel and pre-cast concrete beams are required to be transported by trucks along CityLink and other parts of the road network. The 'Big Build' is a government initiative involving numerous infrastructure projects, including the removal of a number of rail level crossings at multiple locations throughout Victoria.

CityLink comprises a number of elevated road structures and, as part of accommodating these trucks, Transurban reduced the structural and operational risk for travel by developing a tool for use by heavy vehicle operators, allowing them to have visibility whilst en-route of where and how to travel.

### Background

CityLink, being a key route in central Melbourne, was identified as a viable route for the transportation of heavy construction material for rail crossing removal projects. A total of one hundred 156 tonne truckloads were transported for the Carrum and Toorak Level Crossing Removal Projects in 2019 and 2020. Each truck measured up to 5 metres in width and forty-six metres in length.

Due to the heavy weight, trucks are only permitted to travel along certain lanes (or by straddling specific lanes) on the Western Link, which were built to withstand heavy loads up to 400 tonnes. These lanes are identified as Heavy Load Platform (HLP) lanes. There are also speed restrictions (to 10km/h) when traveling on the HLP lanes to reduce dynamic deflection and impacts to associated expansion joints. This means that truck drivers need to be aware of the elevated structures and bridge crossings and understand how to navigate the network.

The CityLink structures are gazetted to accommodate trucks of up to 68.5 tonnes on Western Link and 77.5 tonnes on Southern Link, so the above travel is more than twice the gazetted load limit.

### Tool Description and Use

In consideration of the structural and operational risks of managing these heavy vehicles, a custom geo referenced Google Map was developed to visually highlight the lanes required for the trucks to travel on/straddle, and where the trucks would need to start braking to meet speed restrictions. It also allowed trucks to position themselves correctly on the roadway, reducing late merges that could impact surrounding traffic. This information was displayed in real time as the driver was en-route on the standard Google Maps app on a device with GPS capability such as a smart phone or iPad.

To ensure that drivers used the tool, a condition of the National Heavy Vehicle Regulator Access Permit for CityLink was imposed requiring its use. Tracking of the tool open count was also recorded. Transurban employees set up the custom map on drivers' iPads and demonstrated the functionality of the Google Maps app for the purposes of travel with each driver. All vehicles had a dash mounted cradle for the device and once driving commenced, the device would not need to be physically touched at all during travel.

## **Conclusion**

Using a visual tool in real time allowed truck drivers to safely transport the heavy loads by travelling in appropriate lanes, managing speed safely and merging safely through adequate warnings of merge requirements.

All heavy load movements to date have been managed efficiently and safely without any incidents being directly attributable to the heavy trucks. Engagement with heavy vehicle operators highlighted the value of the tool as it was easy to use and follow the maps while travelling. Further, CityLink's traffic control room operators noted the high level of compliance by vehicles in relation to speed and positioning on the carriageway.

For Transurban, this approach for heavy vehicles has set a blueprint for managing similar activities for future infrastructure projects.

## **About Transurban**

Transurban builds and operates roads in Australia, the USA and Canada. Our purpose is to strengthen communities through transport and the safe system approach underpins our road safety strategic framework. Transurban reports on its road safety KPIs, including the rate of serious injury crashes, and commissions independent research and analysis to inform our operations provide a safe environment for people using our network.

## Country Driver Behaviour

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### Abstract

Road deaths in regional Victoria have increased, with at least half of all Victorian road fatalities occurring in regional Victoria since the mid-2000s. Internal TAC research suggests that the majority of people killed on roads in regional Victoria are residents of regional Victoria. A large proportion of these died close to home. Survey results suggest there are few significant differences in self-reported road safety behaviours between regional and metropolitan residents; and corresponding potential outcome(s) given greater exposure on higher speed rural roads were explored. This study primarily investigates differences in road safety related attitudes and behaviours between residents of regional Victoria and their metropolitan counterparts; and is focused on 2018 results. Expanded Road Safety Monitor results from 2019 will be available at the time of presentation.

### Background

Since 1989, long term fatality trend data shows the proportion of lives lost on regional roads is increasing, from just under half (48%) in the ten years from 1989 to an average of 55% over the last ten years<sup>i</sup>. The proportion of the Victorian population who live in regional Victoria has remained constant at around one in four<sup>ii</sup>. High level analysis of Victorian fatalities in 2019 shows that 78%<sup>i</sup> of deaths in Regional Victoria involve regional Victorians.

### Methodology

The TAC has surveyed Victorian drivers since 2001 to determine attitudes to and self-reported behaviours about a variety of Road Safety issues. In 2018, 1,681 people participated in the Road Safety Monitor (RSM).

RSM results from 2018 were analysed to determine any underlying differences between drivers who live in Regional Victoria<sup>iii</sup> and those in Urban Victoria. In light of the continuing increase in road fatalities in regional areas, the RSM was expanded to target residents of regional Victoria to explore in greater detail their opinions about and attitudes to road safety issues that are pertinent to residents of regional Victoria. Generally, 4-500 residents of regional Victoria are surveyed each year as part of the RSM. It is expected that an additional 900 regional Victorians will be included annually.

### Results

Looking at 2018 RSM data (Table 1) there is little evidence to demonstrate that drivers in regional Victoria are more likely than drivers living in Major Urban Areas to drink drive, drug drive, use handheld mobile phones while driving or drive while fatigued<sup>iv</sup>.

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<sup>i</sup> TAC completed an investigation into 2019 fatal crashes on road in regional Victoria to determine the residency of fatalities on our roads. Distances between the postcode of each crash location and postcode of residence were analysed.

Table 1: Driver behaviours in Major Urban areas v Elsewhere in Victoria

	Major Urban	Elsewhere in Victoria (Other Urban / Rural Balance)
Drink driving	5.8%	3.9%
Drug driving	2.2%	2.5%
Mobile phone use	34.6%	31.5%
Fatigued driving	36.2%	41.1%
Sample size	1090	474

Regional Victorians self-reported driving around 30% further than their urban counterparts (on higher speed roads), and were more likely to speed on 100km/hr roads (51% vs 40%), buy a second hand car (19% vs 11%), drive a light commercial vehicle (13% vs 4% drive a ute), or ride a motorcycle (11% vs 5%), than their urban counterparts (Table 2).

Table 2 Driver behaviours and exposure risk profile – Regional vs Urban

Risky behaviour and exposure	Regional Victorians	Urban Victorians
Distance driven	15.8k km	12.1k km
Likely to exceed the speed limit on 100km/hr roads	51%	40%
Concern about the quality of roads (raised as an issue)	10%	3%
Likely to drive a light commercial vehicle (i.e. utility)	13%	4%
Likely to ride a motorcycle	11%	5%

## Conclusions

Results from the TAC's Road Safety Monitor show that despite regional and urban Victorians reporting similar rates of risk taking behaviour, regional Victorians are engaging in these behaviours on higher speed roads, on roads that are in worse condition, in less safe cars, drive longer distances, and are more likely to speed on high speed roads. This results in increased crash risk and exposure, meaning they are more likely to have poor injury outcomes.

Findings from the 2019 iteration of the RSM will provide further insights into the issues faced by Regional Victorians, along with their attitudes relating to various road safety behaviours. This will enable the TAC to deliver more targeted and relevant road safety messaging to residents of Regional Victoria.

## References

TAC Road Safety Monitor (2018) prepared for the TAC by Wallis Market & Social Research

<sup>i</sup> TAC Fatal Diary, based on police reported data, extracted on Monday 10 February.

<sup>ii</sup> ABS 3101.0 various years. Regional population ranges from 24 – 26%

<sup>iii</sup> For the purposes of the RSM, *Major Urban* centres in Victoria represents a combination of all Urban Centres with a population of 100,000 or more (for example, Melbourne, Geelong, Ballarat). *Elsewhere in Victoria* refers to all other areas in Victoria.

<sup>iv</sup> Significance testing to a 95% significance level between subgroups was conducted. In addition, a multiple comparison correction (False Discovery Rate) has been used to reduce the rate of erroneous findings. There are *no* significant differences between residents in Major Urban centres and those located Elsewhere in Victoria unless otherwise stated.

## Pre-crash driver reactions from event data recorders

Sam Doecke<sup>a</sup>, Martin Elsegood<sup>a</sup>, Giulio Ponte<sup>a</sup>

<sup>a</sup>Centre for Automotive Safety Research, University of Adelaide

### Abstract

A considerable number of modern vehicles contain event data recorders (EDRs) that detect when a collision has occurred and log the last few seconds of driving data prior to the crash. The Centre for Automotive Safety Research's EDR study (CASR EDR) that began in 2017 has collected 335 EDR files from crashed vehicles and matched them to police reports and injury data from hospitals. EDR files from the bullet vehicles in this sample were analysed in order to gain fresh insights into pre-crash driver reactions. Only half of the drivers engaged in hard braking and/or evasive steering prior to a crash and the average speed reductions are generally lower than 14 km/h. This may have implications for the effectiveness and operation of vehicle technologies that seek to improve pre-impact braking or autonomously steer around a hazard and speed limit policies that are based on safe impact speeds.

### Background

A considerable number of modern vehicles contain event data recorders (EDRs) that detect when a collision has occurred and log the last few seconds of driving data prior to the crash. Data downloaded from the EDR of a crash-involved vehicle can reveal key information related to pre impact driver behavior through their recording of the accelerator and brake pedal use, speed, and steering wheel angle. The CASR EDR study that began in 2017 has collected 335 to the end of 2019. This extended abstract presents an analysis of driver reactions in the seconds before a crash from the CASR EDR data.

### Method

EDR data from crashed vehicles was accessed at a holding yard for written off vehicles. The vehicle is matched to a police report for the crash and hospital data if it was an injury crash. This sample has been found to be broadly representative of South Australian crashes (Elsegood, Doecke & Ponte, 2019).

Most of the EDR files contained 2.5 to 5 seconds of pre-crash data that includes speed and a binary measure of brake use (on/off). These data were used to determine if the driver had engaged in heavy braking ( $>0.3g$ ), prior to impact. Average speed reductions for each crash were calculated by subtracting the impact speed from the travel speed. A limited number of the EDRs also contained pre-impact steering wheel angle. This was used to determine in the driver had engaged in pre-crash evasive steering. Only cases where the EDR data was from the bullet, or striking, vehicle were included in this analysis.

### Results

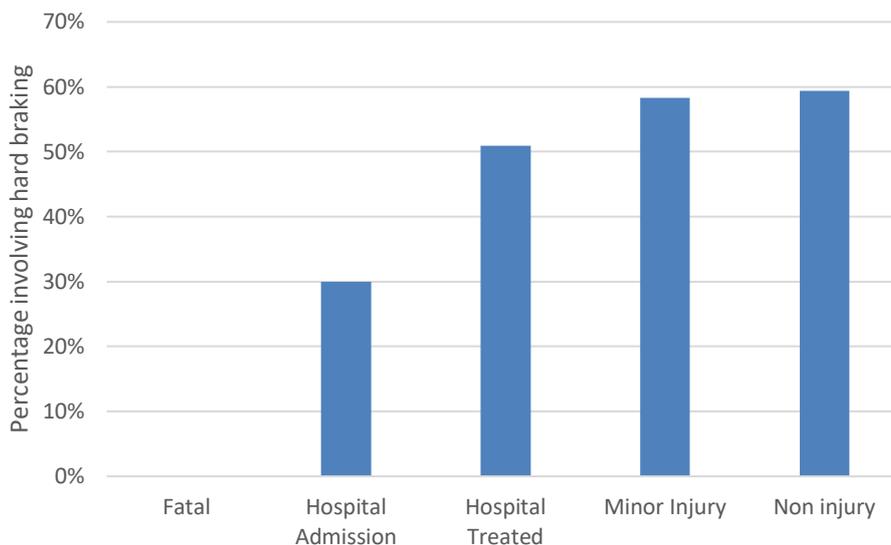
A total of 155 vehicles matched the criteria of containing pre-crash EDR data and were from a bullet vehicle. Forty-three of these contained information on pre-impact steering. Of these, 24 (56%) engaged in emergency steering, and seven did so without also braking. Table 1 shows the percentage of drivers that engaged in hard braking prior to the crash, and the average speed reduction of all vehicles. Half of drivers engaged in hard braking prior to the crash. Drivers were most likely to have braked hard before a rear-end crash and least likely if they hit a parked vehicle or had a head on crash. For most crash types the average speed reduction achieved before impact was less than 14 km/h, with only rear end crashes and single vehicle crashes having higher average speed reductions. Some

caution should be taken in comparing results between crash types due to low numbers in some categories.

**Table 1. Pre-impact braking and average speed reduction by crash type**

Crash type	Number	Pre impact hard braking	Average speed reduction (km/h)
Hit parked vehicle	8	25%	4.5
Head on	10	30%	13.5
Right angle / right turn-adjacent	14	43%	11.0
Single vehicle	38	44%	29.9
Right turn-opposite	21	57%	9.8
Rear end	51	71%	16.9
Other	13	31%	13.0
<b>Total</b>	<b>155</b>	<b>51%</b>	<b>17.0</b>

The percentage of drivers that had engaged in hard braking was found to reduce as the severity of the crash increased (Figure 1).



**Figure 1. Percentage of bullet vehicle drivers that engaged in pre-impact hard braking by crash injury severity**

**Conclusion**

EDR data from the CASR EDR study has allowed fresh insights into pre-crash driver reactions. It was found that only about half of drivers engage in hard braking and/or evasive steering prior to a crash, but this proportion was much reduced at high injury severities. This may have implications for the effectiveness and operation of vehicle technologies that seek to improve pre-impact braking or autonomously steer around a hazard. The average speed reductions found can be utilized in speed limit policies that are based on safe impact speeds.

**References**

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## A Mixed-Methods Study Examining the Impact of Legal Enforcement on Concealed Phone Use while Driving

Verity Truelove<sup>a</sup>, Oscar Oviedo-Trespalacios<sup>b</sup>, James Freeman<sup>a</sup>, Jeremy Davey<sup>a</sup>

<sup>a</sup>Road Safety Research Collaboration, University of the Sunshine Coast, <sup>b</sup>Centre for Accident Research and Road Safety – Queensland (CARRS-Q), Institute of Health and Biomedical Innovation (IHBI), Queensland University of Technology

### Abstract

Legal countermeasures have been implemented in Australia and many jurisdictions worldwide in an attempt to reduce mobile phone distracted driving. However, an important factor that has frequently been overlooked is that legal countermeasures may counterintuitively promote the behaviour of trying to conceal the phone while driving. This study used a mixed method design, consisting of focus groups and a longitudinal survey, to examine concealed phone use while driving among young Queensland drivers. The focus groups identified that reading messages while driving was reportedly the most frequently engaged in phone use while driving behaviour and it is easy to conceal, therefore this behaviour was the focus in the longitudinal survey. The overall results revealed that the current perceived certainty of being apprehended for phone use while driving has a limited deterrence influence for concealed phone use while driving, however avoiding punishment is a strong predictor of future engagement in the behaviour.

### Background

Using a mobile phone while driving is a dangerous and complex behaviour and without appropriate intervention, the prevalence of this behaviour is likely to increase. Young drivers are reportedly the most frequent offenders of this behaviour (e.g. Oviedo-Trespalacios, Haque, King, & Washington, 2016), therefore it is important to reduce phone use while driving among this demographic. Legal countermeasures (e.g., a fine and demerit points) have been implemented in many jurisdictions worldwide with the intention of reducing the rates of engagement in mobile phone use while driving. However, some studies that have examined the rates of phone use while driving before and after the implementation of these countermeasures found that rates of the behaviour did not significantly decrease (Ehsani, Bingham, Ionides, & Childers, 2014; Foss, Goodwin, McCartt, Helinga, 2009; Goodwin, O'Brien, & Foss, 2012; Highway Loss Data Institute, 2010). It has been suggested that drivers may be adapting their behaviour to avoid police by attempting to conceal their phone when using it while driving (Gauld, Lewis, & White, 2014; Oviedo-Trespalacios, Haque, King & Washington, 2018). There has been limited research focus on how legal enforcement can impact concealed phone use while driving behaviour, therefore, that was the focus of this study.

### Study 1 Method

Eleven focus groups ( $n = 60$ ) consisting of young drivers aged between 17 and 25 years were conducted. Participants were asked about the type of phone use while driving behaviour they believed to be most common as well as their perceptions towards legal enforcement and phone use while driving.

### Study 1 Results

The majority of participants reported they believed reading messages was the most common type of phone use while driving behaviour and this behaviour may be easy to conceal. It was also identified that police officers can capture concealed phone use while driving in certain scenarios, however, drivers who use their phone are likely to have experienced the avoidance of punishment. Study 1 results were used to guide study 2.

## Study 2 Method

A longitudinal repeated measures survey was conducted at two time points, approximately 3 months apart and consisted of young drivers aged between 17 and 25 years ( $n = 192$ , 69 males). At time 1, participants were asked about their perceptions towards the certainty of being apprehended for phone use while driving and their experiences with punishment avoidance, as well as their demographic details. At time 2, participants were asked to report their engagement in both concealed and general reading messages while driving.

## Study 2 Results

Drivers reported engaging in concealed reading messages while driving significantly more frequently than general reading messages while driving. Experiencing punishment avoidance was a significant predictor of engaging in concealed reading messages while driving. Meanwhile, the perceived certainty of being apprehended for phone use while driving was not a significant predictor.

## Conclusion

The results support previous research suggesting that using police avoidance strategies for phone use while driving increases the incidence of this behaviour (Oviedo-Trespalacios, 2019). A high perceived certainty of apprehension is considered a cornerstone of effective deterrence (Piquero et al., 2011), however based on the results it can be suggested that experiences of punishment avoidance are lowering drivers' perceived certainty. Further, it can be suggested that enforcement strategies that capture concealed phone use and limit opportunities for punishment avoidance, such as the use of cameras, are necessary to decrease rates of mobile phone distracted driving.

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## **Injury prevention hot-topics: trauma associated with seatbelt non-use and ute occupants**

Paulette Ziekemijjer<sup>a</sup>, Jodi Page-Smith<sup>a</sup>, Amanda Reynolds<sup>a</sup>

<sup>a</sup>Transport Accident Commission

### **Abstract**

An investigation into Victorian road trauma trends combined with attitudinal and behavioural data in relation to seatbelt non-use and involving ute<sup>1</sup> occupants is presented. The two top selling cars in Australia are light commercial vehicles (LCV) (Heckscher, 2020) specifically utilities. 7% of Victorians report driving utes (RSM2018) with drivers of utes, almost all males, being significantly more likely to engage in dangerous behaviours than other drivers. Additionally, Victorians report high seatbelt use compliance while driving (97%) or a passenger (96%), with ute drivers less likely (91%) to always wear their seatbelts when driving.

### **Background**

An observed increase in unbelted vehicle occupant fatalities and the increase in utes in the Australian fleet prompted an investigation to inform injury prevention. Vehicle registration figures<sup>2</sup> reveal that the LCV fleet (including utes) has grown at a faster rate than any other vehicle type. The proportion of Victorian vehicle registrations that are LCVs has increased from 13.8% in 2010 to 14.5% in 2019. The proportion of vehicle occupant deaths has also increased from 7% in 2010 to 23% in 2019. 84% of vehicle occupants killed in LCVs involved utes.

### **Method**

Victorian road death data was extracted from the TAC Fatal Diary<sup>3</sup>. Victorian serious injury data was extracted from TAC's linked file<sup>4</sup>. The fatal and serious injury datasets were analysed to determine seatbelt non-use rates, where information was available; and vehicle types for fatally and seriously injured occupants.

The TAC has surveyed Victorian drivers since 2001 to determine attitudes to and self-reported behaviours about a variety of road safety issues. In 2018, 1,681 people participated in the Road Safety Monitor (RSM2018). RSM2018 results were analysed to identify any relevant attitudinal or behavioural factors.

### **Results**

#### ***Seatbelts***

Unbelted vehicle occupant fatalities increased from an average of 18% in 2014-2018 to 27% in 2019<sup>5</sup>. Most occurred in rural Victoria, with 12% in 2014-2018 increasing to 20% in 2019. Seatbelt non-use in seriously injured vehicle occupants was constant from 2014-2018<sup>6</sup>.

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<sup>1</sup> Ute, utility and pick-ups (light commercial vehicles).

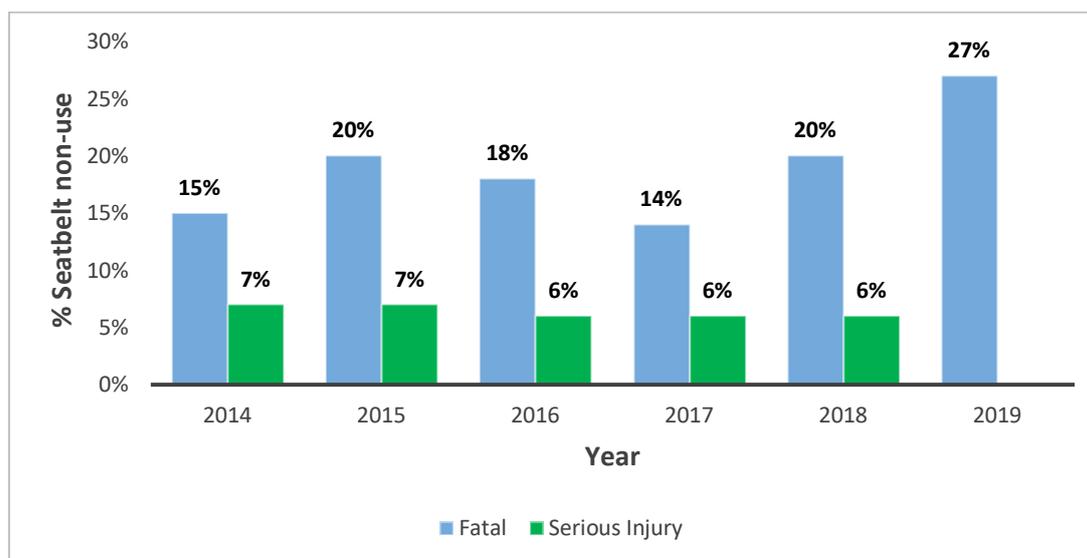
<sup>2</sup> Australian Bureau of Statistics

<sup>3</sup> TAC Fatal diary is based on Victoria Police reported data and subject to change as more information becomes available

<sup>4</sup> TAC's linked file contains TAC claims and hospital data; VicPol crash data and VicRoads RCIS data.

<sup>5</sup> Proportion of seatbelt non-use of vehicle occupant fatalities was determined using only known seatbelt status as the denominator.

<sup>6</sup> TAC is yet to receive the full 2019 data.



**Figure 1. Proportion of Victorian drivers and passengers who were not wearing a seatbelt when killed or seriously injured, when seatbelt status was known.**

Overall, RSM2018 reported Victorian road users were 95% compliant with seatbelt wearing; however, male passengers were slightly less likely (94%) to wear a seatbelt than female passengers (97%).

### Utes

The rate of seatbelt non-use in ute occupant deaths increased to 48% in 2019 versus 28% over the previous 5 years<sup>7</sup>. This compares to 16% of car and station wagon occupants in 2019 who died unbelted versus 14% in the previous 5 years. 9% of seriously injured vehicle occupants (3% Melbourne; 6% rural) were unbelted versus 5% of car and station wagon occupants (3% Melbourne; 2% rural).

RSM2018 reports 7% of Victorians drive utes, the majority (12%) males with 1% females. Ute drivers were significantly more likely to engage in dangerous driving behaviours compared to the overall driving population (Table 1); and were significantly more likely to reside in Rural Balance (17%) and Other Urban (12%) areas than elsewhere.

**Table 1. RSM2018 data comparing proportion of ute drivers engaging in risky driving behaviours compared to the total driving population**

	Ute drivers*	Driving population
<b>Speeding</b>	64%	50%
<b>Drink driving</b>	10%	5%
<b>Using a hand-held mobile phone</b>	44%	34%

\* Ute drivers were 7% of the representative sample of Victorians who report usually driving a car (n=1607).

### Seatbelts and Utes

RSM2018 reported 97% of licence holders<sup>8</sup> wore a seatbelt ‘all the time’<sup>9</sup> when driving, consistent with historical results. 91% of people who drove utes reported wearing their seatbelt all the time. 96% of passengers always wear a seatbelt<sup>10</sup>.

<sup>7</sup> Where seatbelt status was known over the last 5 years (2014 – 2018)

<sup>8</sup> Of licence holders aged 18 to 60 years.

<sup>9</sup> In the last three months.

<sup>10</sup> When a passenger in a car or other vehicle.

## Conclusions

The proportion of LCVs in the fleet, in particular utes, continues to increase. This, combined with ute driver behaviour is concerning. Ute drivers are less likely to wear their seatbelts; significantly more likely to speed, drink drive and use a hand held mobile; and significantly more likely to drive in rural Victoria and other urban areas, generally with higher speed limits. This suggests that ute drivers generally travel at higher speeds and engage in riskier behaviours, resulting in their overall injury risk being higher than other vehicle type occupants. While this study focused on ute occupants, particularly seatbelt use; involvement of utes in crashes with more vulnerable road users must be considered given ute aggressivity.

## References

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TAC Road Safety Monitor (RSM)., 2018. prepared for the TAC by Wallis Consulting Group

## Set Your Phone Then Leave It Alone – An anti-distraction campaign

Joel Tucker<sup>a</sup>, Candice Watt<sup>a</sup>, Natalie Hocking<sup>a</sup>, Tamara Browning<sup>a</sup>

<sup>a</sup>The Royal Automobile Club of Queensland

### Abstract

Driver distraction from interacting with mobile phones is an ongoing issue in Queensland, across Australia and internationally. The Royal Automobile Club of Queensland (RACQ) partnered with the Motor Accident Insurance Commission (MAIC) to develop a campaign aimed at reducing drivers' interactions with mobile phones through education, encouraging a fresh approach through explaining how to set their phones to 'do not disturb' (DND) mode prior to driving. The campaign comprised social and traditional media and included activation events, out of home, cinema, radio, online and television advertisements. Longitudinal market research was conducted in July 2019 (establishing pre-campaign baseline), in August 2019 (following wave 1 of the campaign), and in January 2020 (following wave 2 of the campaign). At the end of the campaign, significant changes were evident – including a significant reduction in hand-held phone use whilst driving and an increase in use of the DND phone function.

### Background

Driver distraction – especially distraction from mobile phones – has been the subject of increasing research and public education campaigns in recent years. Research commissioned by the Queensland Department of Transport and Main Roads (2018) found that Queenslanders perceive mobile phones to be the second highest cause of death and injuries on our roads. Despite this, 70% of Queenslanders admit to using their phone illegally in the car (Department of Transport and Main Roads 2018).

With a long-term goal to reduce crashes where people are killed or injured in Queensland, and reduce the use of unsafe and illegal phone use, the Royal Automobile Club of Queensland (RACQ) partnered with the Motor Accident Insurance Commission (MAIC) to develop a campaign using a fresh creative approach. Rather than tell people not to use their phone while driving, we acknowledged the close relationship Queenslanders have with their mobile phones (making them appear human), then provided an alternative to hand-held (and some hands-free) use while driving via the 'do not disturb' (DND) function.

In summary, the strategy for the campaign was to: get Queensland smartphone users, who have their own strategies to feel safer about using a phone while driving, to stop touching their phones while driving by getting their phones set up prior to driving and using the DND function while driving.

### Campaign outline

The campaign slogan and mnemonic, 'Set your phone, then leave it alone' and graphic device (Figure 1) clearly set out desired behaviour. Targeting Queensland motorists aged 18-54, the campaign was rolled out through the following channels:

- Out of home;
- Television (30 and 60 seconds);
- Cinema;
- YouTube 15 seconds and 45 seconds;
  - [https://www.youtube.com/watch?v=ix8\\_LpwQGY8&feature=youtu.be](https://www.youtube.com/watch?v=ix8_LpwQGY8&feature=youtu.be)
  - <https://www.youtube.com/watch?v=Jw2rnCieBnM&feature=youtu.be>

- Radio 30 seconds;
- RACQ-owned channels – *The Road Ahead* magazine, electronic direct marketing, social media pages, traditional media comment; and
- Social media advertising including boomerangs, long form videos and images.



**Figure 1 – Campaign graphic device**

The campaign was delivered in two waves – one to time with Queensland Road Safety Week in August, and the second for the critical pre-Christmas and New Year period.

### **Research and findings**

A longitudinal research piece was designed around the campaign to understand any change in beliefs and behaviours. The methodology encompassed: pre-campaign baselines (n=1241), one month post-launch (n=743 re-contacts), and five months post-launch (n=316 re-contacts). Other relevant activity in market (for example advertising/education campaigns relating to road safety and mobile phone use) was also taken into consideration when analysing any shifts.

Over the 6-month period there was a positive shift in beliefs about what is and isn't legal behaviour around mobile phones and driving. Awareness of 'safe driving' campaigns increased in this time. The campaign, coupled with other relevant messages in market, has contributed positively to self-reported behaviours.

Regarding behaviour change, a significant decrease was seen in the use of hand-held mobile phone use when driving. It is evident, however, that using a mobile phone whilst driving in general (be it navigation, music, calls, etc.) has not diminished. What has changed, albeit subtly at this stage, is that fewer illegal and/or high-risk behaviours with mobile phones are occurring.

Coupled with a small but meaningful uplift in the awareness and use of Do Not Disturb smartphone functions, there is evidence of the campaign and key message starting to positively shift beliefs and behaviour.

## **Conclusion**

The ‘Set your phone then leave it alone’ anti-distraction campaign proved to be a popular and memorable campaign, which also appears to have achieved some positive driver behaviour change.

Road safety and driver distraction remain key concerns for RACQ and while this campaign is no longer in market, the Club will consider opportunities for similar activity in this space.

## **References**

Department of Transport and Main Roads. (2018). Driver Behaviour & Attitudes Study. Brisbane, QLD: Footprints Market Research.

# TV and YouTube campaigns



- › TV:
- › Youth 45" TVC
- › Tradie dad 45" TVC
  
- › **Online Video – Longform extension of the stories in TV:**
- › Youth 6" YouTube Bumper
- › Tradie dad 6" YouTube Bumper
- › One goodbye could prevent another YouTube
- › One goodbye could prevent another YouTube v2
- › Take a moment to say goodbye - Youth hug
- › Take a moment to say goodbye - Tradie hug



Take a moment  
to say goodbye



Set your phone  
then leave it alone

MAIC Motor Accident  
Insurance Commission

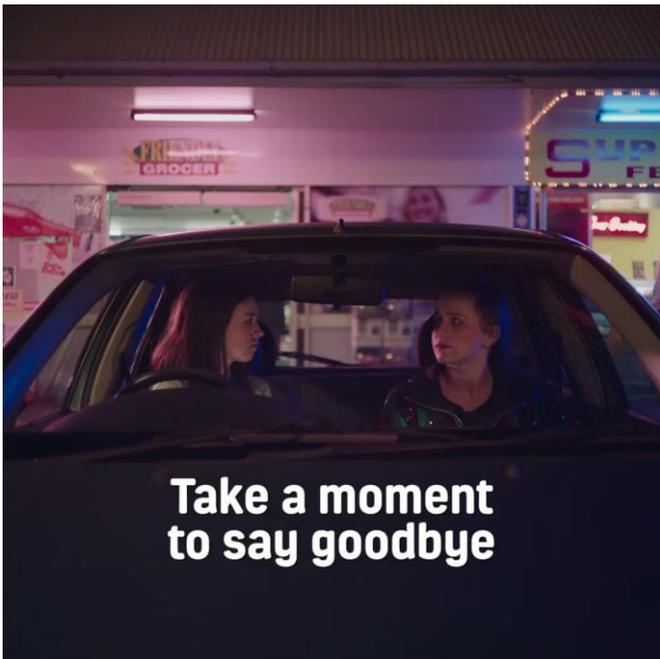
RACQ



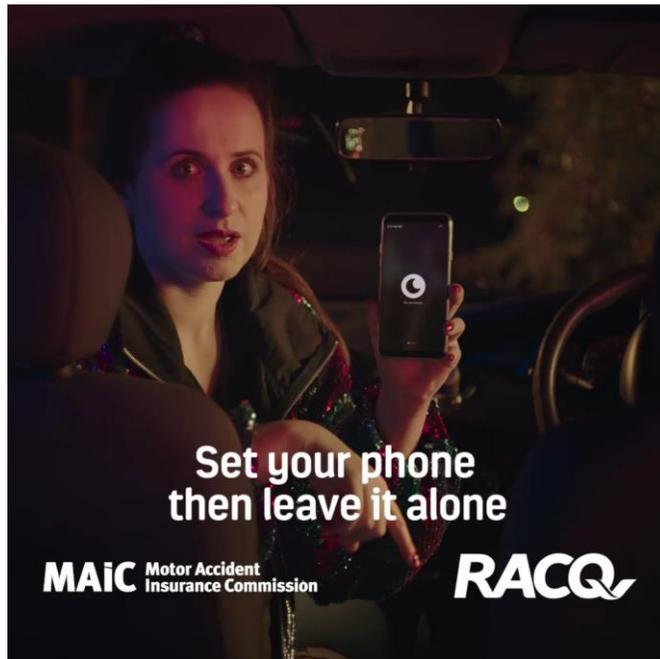
Remember why  
you say goodbye

RACQ

Social



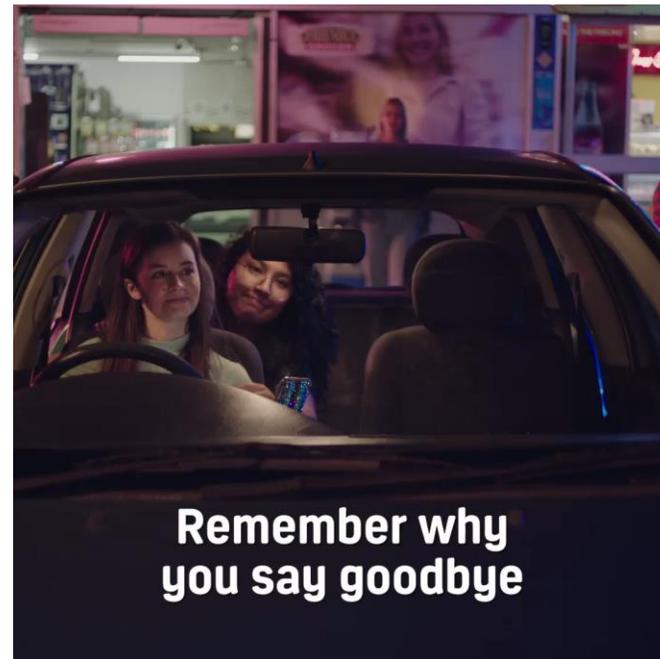
Take a moment  
to say goodbye



Set your phone  
then leave it alone

MAIC Motor Accident  
Insurance Commission

RACQ



Remember why  
you say goodbye

# Channel roles

We will employ a two pronged media strategy to de-normalise phone use while driving and drive direct behaviour change at the point of behaviour (when people are in the car).



1.

**De-Normalise the Behaviour.**  
De-normalise the behaviour & encourage strategies to prevent the behaviour through high reaching and high impact channels.

**Shortlisted Mediums:**  
TV, YouTube, Catch-Up TV, Social Video, Cinema.

**Awareness.**



2.

**Directly Change Behaviour.**  
Reach people when they are in the car to drive direct behaviour change in the moment.

**Shortlisted Mediums:**  
Radio, OOH.

**Action.**

# Creative assets

## Bus backs



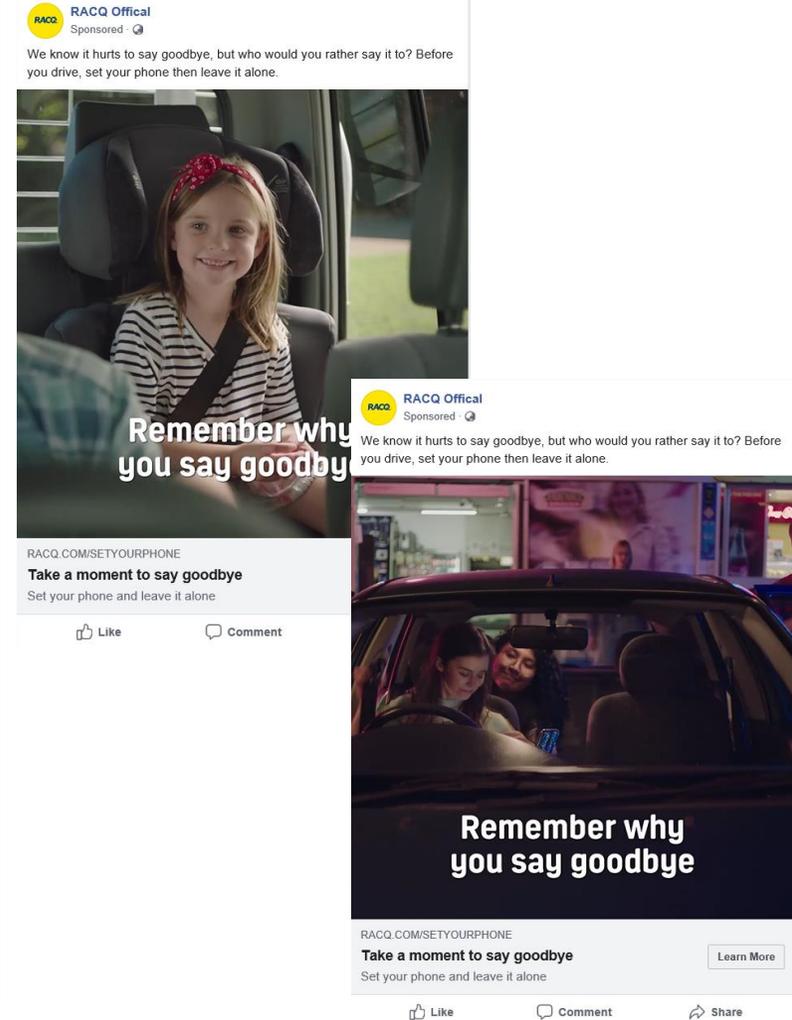
## Double page spread CEO Magazine and 1/4 Road Ahead



## Window stickers



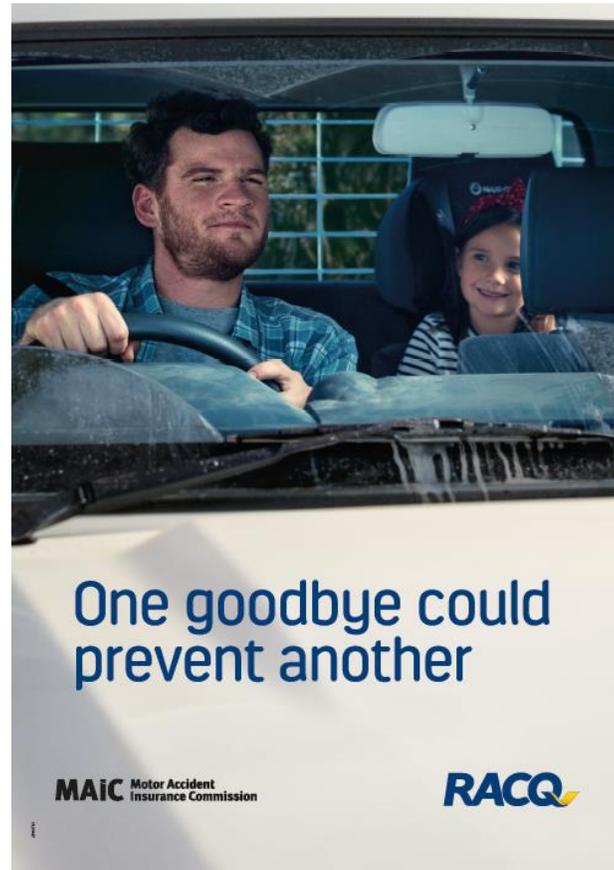
## Social ads



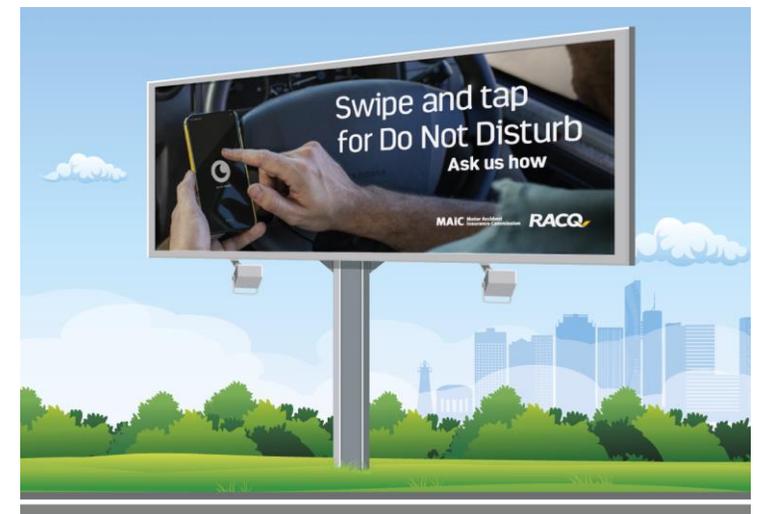
# Creative assets cont.



In store point of sale



Ekka Club House activation  
Driving simulator game & merchandise  
giveaway



# Block plan



		August				September					October				November				December					January	
		4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12
TV (TARPs)	MTV 30"	[Block]										[Block]													
	RTV 30"	[Block]										[Block]													
Social (Views)	10" Video	[Block]				[Block]																			
Online Video (Views)	15" Video	[Block]				[Block]																			
Cinema (Screens)	30" Ad	[Block]																	[Block]						
Radio (spots)	97.3 FM	[Block]																							
	Hit 105	[Block]																							
	4MMM	[Block]																							
	NOVA	[Block]																							
	4KQ	[Block]																							
	HOT TOMATO	[Block]																							
	SEA FM	[Block]																							
	OOH (buses)	Busbacks	[Block]																						

## **When The Rubber Hits The Road - Australia's Motor Accident Injury Insurance Schemes And Autonomous Vehicles**

Katie Minogue

Principal Lawyer, Maurice Blackburn Lawyers

### **Abstract**

With human factors consistently playing a role in motor vehicle accidents, autonomous vehicle technology is expected to dramatically improve road safety. But significant challenges arise in ensuring that, under motor accident injury insurance (MAII) schemes across Australia, coverage is uniform whether a person is injured or killed in an automated vehicle crash or in an accident involving a human driver. MAII schemes differ in the ways they provide compulsory personal injury insurance cover for crashes and a consistent national approach to injury insurance is imperative. Significant reform work is underway with the National Transport Commission (NTC) specifically targeting the area of motor accident injury insurance (MAII) in their 2019 policy paper. This talk will report on the reform work being done as well as canvassing the ongoing challenges of insurance coverage in accidents caused by automated vehicles.

### **Extended Abstract**

Human factors are consistently found to play a role in motor vehicle accidents. For example, Monash University Accident Research Centre's 2020 Enhanced Crash Investigation Study found driver related factors to have contributed to 99.5% of crashes in their study (Fitzharris, M., et al, 2020). It is therefore expected that the introduction of 'autonomous features' such as adaptive cruise control, automatic emergency braking, lane-keeping assist and road-departure mitigation will dramatically improve road safety. As the law stands today, an injured person may be treated differently under Australia's MAII schemes depending on whether they are injured by a human driver or a vehicle operating in autonomous mode. MAII schemes were not designed to contemplate an autonomous system 'driving' a motor vehicle and significant reform is needed to ensure fairness and transparency for all road users.

In its Motor Accident Injury Insurance and Automated Vehicles policy paper released in August 2019, the NTC recognised that reform is needed (National Transport Commission, 2019). This talk will analyse the various proposals for reform as well as the challenges that arise from such reform.

### ***Cost shifting***

MAII insurance premiums are paid by vehicle operators, and the cost of the scheme is also borne by insurers, government and taxpayers. If the current model does not change with the advent of autonomous vehicles, the cost of personal injury claims caused by a failure of an autonomous vehicle will not be borne by the negligent party responsible for the defect.

### ***Reinsurance pool***

The proposal of a national reinsurance pool whereby all parties in the supply chain contribute to a pool of funds through risk-rated premiums. The MAII insurer would then have a right to recovery from the reinsurance pool.

The major problem with this proposal, is that when so little is known about risk at this early stage of autonomous vehicle deployment, setting risk-rated premiums would be very difficult to achieve. If

the risk-rating system is not correctly weighted, wrongdoers would not be encouraged to create change. Additionally, the ‘pool’ system may require faultless parties, who have never contributed to any defect causing an accident, to continually subsidise parties who have contributed to a defect. Further, a reinsurance pool is premature, unwieldy and administratively burdensome.

### ***Right of Recovery***

In the alternative to the reinsurance pool model, another proposal involves insurers utilising existing recovery rights against the autonomous driving system entity (ADSE) or any ‘at fault’ third parties. The ADSE is defined as the party responsible for certification before a car is released to market, as well as the entity responsible for compliance with safety and traffic obligations.

On one view, the ADSE is the entity best placed to take action against risk of defect and therefore should be responsible for the cost of damages.

The proposal of a strict legislated right of recovery which may avoid protracted disputes between insurers, ADSEs, and component manufacturers that would otherwise add unworkable delays and friction costs to the scheme.

### ***Access to Data***

Whether existing processes are sufficient to enable access of autonomous vehicle data for the purposes of establishing liability in relation to a personal injury claim is an important consideration.

Reform is needed to establish a streamlined and cost-efficient mechanism for all parties to an accident (including the injured passenger) to access event data and ensure that no person is worse off financially or procedurally in accordance with the paper’s overarching principle. Early access should result in a reduction of complicated litigation, particularly if data is made available soon after the accident to settle questions of fault at an earlier point in time.

### ***Conclusion***

MAII schemes provide coverage for anyone who has the misfortune to be injured on the road as a driver, passenger, cyclist or pedestrian. It is rare to find ourselves in a period where the next few years may so significantly change such a large and wide-reaching body of entitlements. It is critical that regulatory reform paves the way for equitable coverage for all under MAII schemes, resulting in greater uptake of autonomous technology and greater safety outcomes for all on the road.

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## Safe system capability development in the context of industry

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### Abstract

The safe system approach underpins Transurban's road safety strategic framework. To support our capability in road safety, Transurban has implemented regionally based road safety action plans that reflect the safe system pillars. We have also established a road safety community of practice with members drawn from across business functions and, most recently, developed a bespoke safe system professional development program.

This presentation will cover the motivation for the program, its development approach, implementation and outcomes.

### Background

As one of the world's largest toll-road operators, everything we do works to get people where they want to go, as quickly and safely as possible – from designing and building new roads to researching new vehicle and road safety technology.

The safe system approach underpins Transurban's road safety strategic framework and aligns with the United Nation's Sustainable Development Goals. The strategy includes targets and action plans with an ambition to operate a transport network that is free from fatalities and life-changing injuries. We measure and report on our road safety performance<sup>i</sup> and engage experts to analyse our data, assess our network and evaluate our activities to support our continued road safety efforts.

A key finding of the Australian Government's Inquiry in to the National Road Safety Strategy<sup>ii</sup> (National Review) was a national failure to operationalise the safe system. There is a need to build capacity in organisations to pursue the safe system approach and integrate a harm elimination agenda into 'business as usual'. Transurban's road safety focus aims to go about this in a sustainable way.

### Current capability development actions

To support and extend our leaders' understanding and capability in road safety through the safe system approach, Transurban has developed a safe system professional development program.

To support our employees' understanding and apply safe system to their work, Transurban has established a number of initiatives.

### Development approach

The purpose of this professional development program is to support our people in understanding and applying the safe system approach in everything they do. After attending this program, employees will be able to:

- a. Describe the safe system principles
- b. Identify the key attributes of each safe system pillar
- c. Understand how the safe system aligns with Transurban's mission, strategy and values

- d. Able to apply the safe system to their work
- e. Know where to find more information on the safe system such as guidelines, frameworks and tools and technical training opportunities for employees

Transurban identified Assoc Professor Jeremy Woolley, Director of CASR at the University of Adelaide and co-chair of the National Review to co-design the program with Transurban, given his credentials in road safety and civil engineering, and his engagement approach demonstrated in the National Review.

The design established the learning outcomes and importance of involving a multi-disciplinary team, given the program was to be available for all leaders in the Transurban business. The development included workshops on content and structure, targeted consultation and review, along with a pilot.

### **Program implementation and outcomes**

Key findings from the pilot included the need for pre-reading to establish the background, history and context for the safe system approach, and two versions of the program; a technically based program for employees with an infrastructure, design, engineering and operational technology focus, and a more generic version for corporate-based employees.

Identifying relevant and engaging case studies from across projects, operations and delivery were also key to supporting learning outcomes and demonstrating how Transurban's efforts can contribute to the global, national and state-based road safety targets and activities that aim to eliminate serious road crashes from the transport system.

The program was implemented across all Transurban Australian and North American markets from December 2020 to March 2021 through webinars, given the COVID-19 situation. One hundred and fifty employees undertook the program

The program's impact was evaluated through employee surveys, including describing application of their learning in their work. Overall, 90 percent of responding participants agreed that the program objectives had been achieved, with 100 percent recommending the program to others.

E-learn modules have been created using the program materials and webinar recordings and are now available for all employees through Transurban's learning management system.

### **Conclusion**

Ensuring industry is engaged in road safety and understands the principles and application of the safe system approach will be critical in getting to zero fatalities and life-changing injuries. Transurban has identified this and embedded the approach in its road safety strategic framework, operations and major projects, including a professional development program on the safe system approach.

This presentation will focus on the purpose of the program, process undertaken to develop the program, along with outcomes from the implementation.

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<sup>i</sup> <https://www.transurban.com/content/dam/investor-centre/04/2020-Corporate-Report.pdf>

<sup>ii</sup> [https://www.roadsafety.gov.au/sites/default/files/2019-11/nrss\\_inquiry\\_final\\_report\\_september\\_2018\\_v2.pdf](https://www.roadsafety.gov.au/sites/default/files/2019-11/nrss_inquiry_final_report_september_2018_v2.pdf)

## Demystifying the Automated Vehicle trolley problem

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### Abstract

Future Automated Vehicle (AV) capabilities, cavalierly and irresponsibly informed by Sci-Fi movies or social media, are confusing the public. The media abounds with AV scaremongers portraying future AV as a God-like entity able to decide the life and death of road users. The trolley problem is a theoretical experiment in utilitarianism and deontological ethics. It is often quoted as the ultimate moral quandary that AV will solve despite human unable to reach a consensus about it. This paper highlights the methodological misconception of the AV trolley problem. We argue that the ethical trolley problem should be analysed through the lens of AV technology advances. We show that AV technology is far from being able to solve the trolley problem and are not even aiming for. This paper demystifies the perception that AV could be an intelligent weapon. It contributes to improve AV community acceptance.

### Introduction

The trolley problem is described as an AV facing a split path. Each path leads to the unavoidable killing of a pregnant pedestrian or an elderly man in a wheelchair. Which path should the AV take? This paper unfolds the AV trolley scenario into AV's technical abilities and the latest machine ethics developments.

### *Automated Vehicle functionalities*

There are three fundamental core functions to enable (AV) navigation: perception, motion planning and control. Perception refers to the ability of an AV system to sense (detection and identification) its surroundings (e.g., lane markings) and extract relevant knowledge via sensors. Motion planning specifies trajectories by adhering to a set of criteria, such as maximising safety (Clausmann et al, 2019). Control function executes the planned path with lateral and longitudinal actuators.

### *Machine with ethical behaviour*

How ethical principles can be translated into an algorithm and endow machines with such properties is a new field of machine ethics (Pereira and Saptawijaya, 2016). One approach consists of explicitly formulate rules (e.g. deontic logic) (Van den Hoven, 2017). Recent approaches use supervised machine learning (Kasenberg et al., 2018). It learns from training data featuring ethical decision-making scenario. A trolley problem situation is an extremely rare situation. Results of a Deep learning algorithm can be biased and depends on the quality/quantity of the trained data set (Lecun et al, 2015). Rule based ethics machine are more likely to provide deterministic results.

### The trolley scenario viewed from the AV's perspective

- Perception:
  - The perception layer can detect the pregnant woman or the elderly man in a wheelchair as risky hazards, however, it cannot identify them as being old or pregnant. The use of machine learning to identify and classify objects has not reached expected robustness.
- Motion planning

- Associating a moral value to identified obstacles represents a huge leap from the current state of the art. Higher semantic knowledge, such as the value of life that we, as humans, subjectively attribute to a pregnant/older person cannot be deduced from the perception layer in real time.
- A crash is predicted in a small-time window. Asserting that the AV's motion planner has to choose between two crash scenarios is fundamentally flawed. It assumes an unlikely succession of wrong planning decisions. The deadly situation should have been predicted during the previous time steps and remediated (e.g. reduce speed).
- Control
  - The premise of the trolley problem is that perception, motion planning and control layers failed to predict the deadly situation. It is highly unlikely that a set of AV errors could lead to the specific trolley problem.
  - AVs can fail. However, most of the motion planners use a safety boundary to manage the unknown (Vanholme et al., 2013). AVs must be capable of handling most faults and be fail-safe under clear operational domain to be permitted on the road (ISO-26262).

## Conclusion

AV research and development will focus on safety for years to come (Demmel *et. al*, 2019). We need significant societal and technological progress to endow AVs with ethical behaviour.

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## Department of Transport and Bosch CAV Highway Pilot Trial on Victorian Rural Roads

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### Abstract

As part of Victoria's *Towards Zero* 2016-2020 Road Safety Strategy, the Department of Transport (DoT), the Transport Accident Commission (TAC) and Bosch partnered together to develop and trial automated vehicle technology. The prototype SAE L3 Automated Driving System (ADS) was developed by Bosch, integrated in a donor vehicle, and specifically adapted to operate on Victorian high-speed rural and regional roads, where a disproportionate amount of road trauma occurs. This innovation project aims to contribute towards the long-term reduction of road trauma in this unique environment.

The trial identifies key focus areas for road safety practitioners and road managers, assisting them in enabling Automated Driving (AD) on Victorian regional roads to reduce road trauma. Challenges and enablers influencing the ability of an ADS to perceive and navigate the unique Victorian rural and regional road environment were identified throughout the trial. Key points in ensuring a higher AD functional availability include the consistent application of road standards, availability of up-to-date road network data and ongoing road maintenance.

### Background

The Victorian government's *Towards Zero* 2016-2020 Road Safety Strategy set a bold agenda for road safety in Victoria. One area of focus for the strategy was rural roads - where more than half of all road fatalities occur (Victorian Government, 2016). Drivers on country roads are five times more likely to be killed than those in metropolitan areas (Rooney, 2018); Connected and Automated Vehicle (CAV) technologies have the potential to substantially reduce deaths and serious crashes in this environment by addressing preventable lane departure crashes attributed to driver distraction and fatigue (Dawson et al. 2017).

The *Towards Zero* CAV Trial Grant program, managed by DoT and funded by the TAC and DoT, awarded Bosch \$2.3m to develop self-driving capability on Victoria's high-speed rural roads. The project commenced in October 2018, data collection and on-road testing began in 2019 and the project concluded in December 2020.

### Objectives

A key objective of the trial was to expand the operational design domain (ODD) of Bosch's prototype Highway Pilot (HWP) function to Victorian rural highways: In doing so, the specific requirements for enabling automated driving technologies in that environment were investigated. The outcomes formed a body of knowledge to support road infrastructure planning and legislation decisions maximising the safety potential of these new systems.

### Approach

The CAV Highway Pilot Trial set out to demonstrate automated driving in live traffic at three rural highway locations in Victoria. The trial locations were selected based on road safety data, as well as environmental, infrastructure and traffic characteristics considered to be representative of rural road conditions across the state. The resulting locations were the Mornington Peninsula Freeway, Western Highway and the Bass Highway.

For this trial, Bosch used a donor vehicle to install their own prototype SAE Level 3 ADS. It comprises a highly networked combination of lidar, radar and camera sensors, connectivity features, GPS and high performance computing. The technology employed is capable of actively monitoring its environment with a 360 degree field of perception, and maintaining accurate onroad localisation in environments with varying feature densities. In combination with advanced behavioural planning capability, it allows for automated multilane functionality under real-world traffic conditions.

Bosch collected localisation and mapping data, generated custom High Definition (HD) maps of the routes, developed system functionality, and evaluated system behaviour and performance. In addition, live traffic demonstrations of the technology were conducted for the trial participants at each of the three locations.

Further work was directed towards developing connectivity-based services such as real-time hazard monitoring, and integrating dedicated human machine interface and driver monitoring technology based on human factors research.

## Outputs

The project was completed in December 2020. Throughout the trial over 32 TB of development data was captured, and 3,000 kms of driving was conducted in automated mode making it the largest trial of its kind in Australia to date. The key lessons learned include:

- With dedicated development, Automated Driving technology could be adapted to work within the Victorian rural environment
- Regional roads have a relative scarcity of roadside features and lack of environmental information that an automated driving system processes to operate
- Radar landmark-based localisation (a mapping layer created from radar data) was able to compensate in situations where inputs from camera-based landmarks and differential GNSS were degraded or unavailable
- Up-to-date information on the state of the road network (either crowd-sourced or provided by road managers) will assist in deciding which roads should be considered as part of the initial ODD for automated vehicles.

The project identified key enablers for AD function availability:

- Consistent and reliable standards for roads including correlation between road classification and infrastructure would simplify inclusion/removal from function ODD
- Well maintained road networks and associated digital infrastructure allow for higher availability of AD functions, this includes:
  - Quick detection and repair of damaged infrastructure
  - Well-defined road topology and markings
  - Emergency lane availability
  - Prevention of vegetation encroachment
  - GSM network and GNSS quality of service

The trial has shown that it is possible to enable highly automated driving on Victorian rural roads, however jurisdictions can assist in improving the availability of those functions.

## Conclusion

The CAV Highway Pilot Trial was a large-scale, real-world trial which provided insight into the challenges with operating an ADS under Victorian rural road conditions. Automated driving systems must be able to navigate safely to fully realise the road safety benefits of CAV technology,

highlighting the importance of collaboration between industry and government agencies. Victoria needs to consider the capabilities and limitations of CAV systems in planning for future infrastructure investment.



*Figure 1. The Bosch HAD vehicle undergoing testing*

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## Exploring the safety potential of Cellular-V2X based vehicle connectivity, results from the Advanced Connected Vehicles Victoria trial

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### Abstract

The Advanced Connected Vehicles Victoria (ACV<sup>2</sup>) trial is a partnership between the Department of Transport Victoria, Telstra, Lexus Australia and the Transport Accident Commission. This trial developed and tested a connected vehicle system using Cellular Vehicle-to-Everything (Cellular-V2X) technology to enable communication between vehicles and with a network hosted platform to improve safety.

The ACV<sup>2</sup> system enables safety warning messages to be delivered to vehicles with very low latency using the existing Telstra 4G network. This approach to connectivity gives the potential for wide-scale deployment without significant roadside infrastructure expenditure, which will be a large hurdle for adoption. It is anticipated that this technology solution could facilitate earlier realisation of vehicle connectivity and its potential safety benefits.

The trial successfully tested six road safety-oriented use cases that consider speed, intersections, Vulnerable Road Users (VRU) and rear-end crashes. The key lessons learnt and implications for future road safety applications will be shared.

### Background

The Victorian Government's *Towards Zero 2016-2020* Road Safety Strategy acknowledged the potential of future vehicle technologies in reducing road trauma. Through the strategy, the Victorian Government, DoT and TAC allocated funding for the on-road trial of vehicles with connected and/or automated features to understand their potential safety benefits. As part of the Connected and Automated Vehicle Trial Grant Program, Telstra and Lexus Australia were awarded a matching grant of up to \$3.5m to support the conduct of a two-vehicle trial of a Cellular-V2X system – the ACV<sup>2</sup> trial.

ACV<sup>2</sup> is a Co-operative Intelligent Transport System (C-ITS) trial. C-ITS enables communication between different actors in the transport network for the benefit of safety, network efficiency and environmental performance. Despite a significant period of development, a C-ITS ecosystem is yet to be realised and there are still no new vehicles sold in Australia equipped with C-ITS. Cellular-V2X may accelerate the benefits of C-ITS due to its ability to leverage the existing 4G mobile network infrastructure already in place across much of Australia.

### Objectives

The trial aimed to determine the potential road safety benefit of a Cellular-V2X system. Real-world testing of this new technology solution will help accelerate the development of C-ITS and contribute to global standards development for cellular vehicle communications. The outcomes of the trial for the Victorian Government include specific learnings about the preparation of transport systems for connected vehicles, and a greater understanding of the potential contribution to road safety.

### Approach

The ACV<sup>2</sup> system uses a cloud-based Cellular-V2X cooperative communication platform to connect traffic management systems and other services to vehicles to enable the generation of warning messages to inform drivers of hazardous situations. The trial vehicles report their location to the

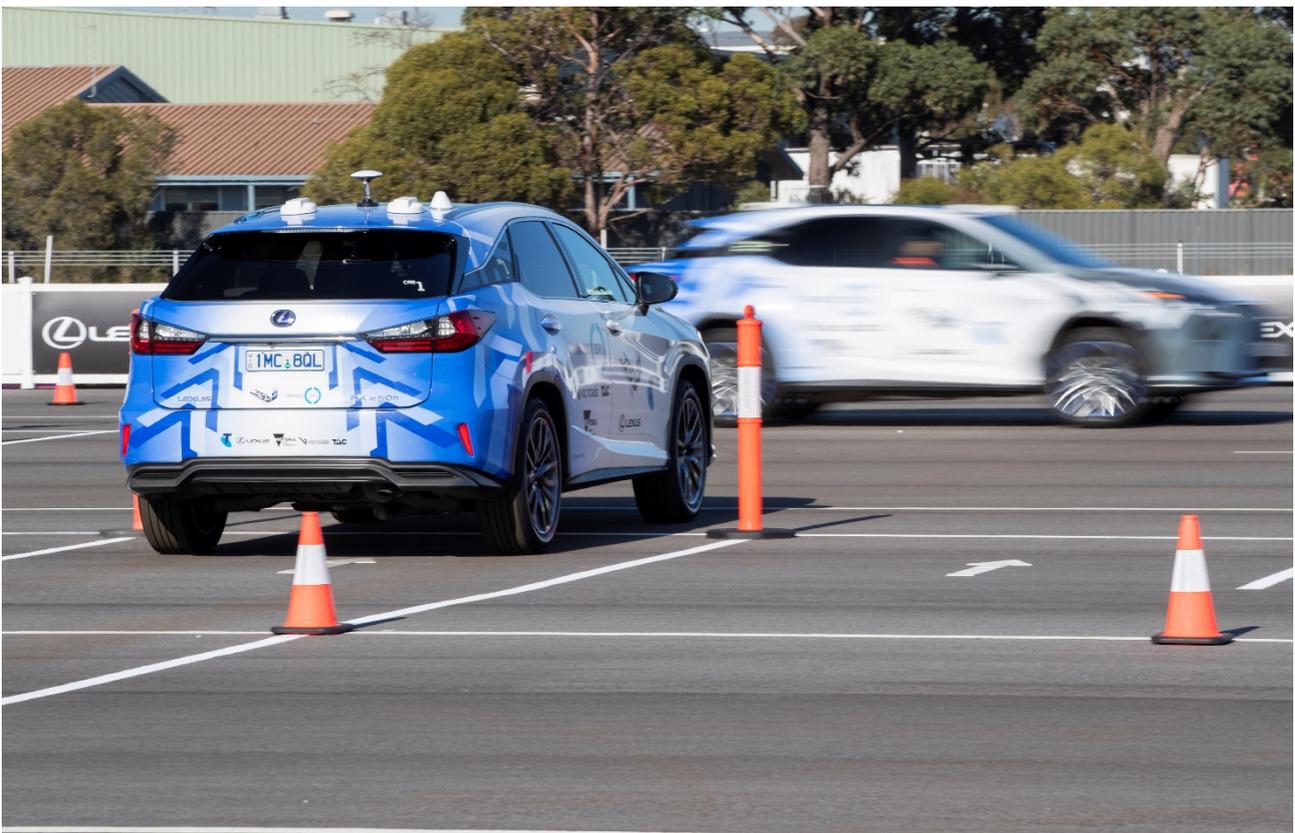
system via ‘cooperative awareness messages’ to enable up-to-date data to be served to the vehicle to provide warnings to the driver. ACV<sup>2</sup> also enabled for direct vehicle to vehicle C-ITS messages to be sent between trial vehicles using the Cellular-V2X ‘off-network’ short range wireless communication protocol to ensure that critical warnings can be shared regardless of the level of cellular coverage.

Six C-ITS use cases were included in the ACV<sup>2</sup> trial with the selection of use cases based on those predicted to have potential for road trauma reductions as found by Austroads (Austroads, 2017). The use cases included warnings for emergency braking, slow or stopped vehicle, overspeed, curve speed, red light violator and right turn warning with pedestrian detection.

### Outcomes

The ACV<sup>2</sup> trial developed and tested six road safety focused use cases to determine the potential of the system to assist in addressing some of Victoria’s road trauma. The practical development of the use cases and their real-world application highlighted the strengths of each use case, areas for improvement and limitations. The in-depth understanding of the system and each use case will enable future study of the potential effectiveness in addressing the targeted crash types.

The trial project is currently in the reporting phase and is due for completion in Q1 2020. A project report is being prepared and the findings from this report will be available at the time of the conference.



*Figure 1. Off-road testing of the ACV<sup>2</sup> system (Photo: Lexus Australia)*

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## **Adapting Automated Vehicle perception for safer roads, results from the Omni-Aware trial project**

Andrew Somers<sup>a</sup>, David Johnston<sup>a</sup>, Joanne Vanselow<sup>b</sup>

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### **Abstract**

An innovation project was funded through the Victorian Government's Towards Zero Action Plan to equip a crash hot-spot intersection as part of the Connected and Automated Vehicles Trial Program. This is understood to be the first long-term deployment of this type within the Asia Pacific region and one of very few around the world. This paper introduces the Omni-Aware technology used in the trial project and will report on the results and lessons learned.

Omni-Aware draws upon Automated Vehicle sensing technology by deploying multiple LIDAR (Light Detection and Ranging) sensors to an intersection to build a highly accurate continuous spatial awareness of all pedestrians, cyclists, cars, buses and trucks.

### **Background**

There has been much interest in the opportunities for Automated Vehicle (AV) technology to assist to achieve road safety outcomes. To investigate the potential for the adaptation of AV technology to a roadside installation, an innovation project was funded through the Victorian Government's Towards Zero Action Plan to equip a crash hot-spot intersection as part of the Connected and Automated Vehicles Trial Program. The Omni-Aware project was funded to explore how some of the safety benefits of AV technology can be brought forward by deployment of technology adapted from these vehicles to the roadside.

### **The Technology Applied**

The Omni-Aware technology uses multiple LIDAR (Light Detection and Ranging) sensors to build a highly accurate continuous spatial awareness of all pedestrians, cyclists, cars, buses and trucks at an intersection. This situational awareness can be used to intervene with hazard warnings ahead of a potential problem and the same awareness can be used for other road management functions. If a near miss or crash does occur, highly detailed information can be made available for analysis to help prevent future crashes.

The use of LIDAR sensors gives the technology precision in its four-dimensional awareness of the position of all types of "objects" including pedestrians, cyclists and buses. This precision matters in an environment where a few centimetres can be the difference between a scare, an injury and death. The focus on LIDAR for the trial project reflects its stronger positional precision relative to radar and cameras. For the trial project, recorded video footage was used with blurring of identifying features such as faces and number plates to validate the interpretation of the LIDAR point data in analysing near misses and crashes.

### **Trial Outcomes**

The highly detailed situational awareness provided by Omni-Aware has been used in real-time to monitor when "objects" get too close and there is a risk of a crash. It has also been used to replay in detail any near misses or crashes that did occur so that Road Safety Victoria and TAC can learn from these and help prevent future crashes.

The intersection safety analysis function was demonstrated through analysis of classes of behaviour (e.g. locations where pedestrians crossed other than in a marked crossing) and through detailed analysis of the one crash observed during the six month trial period on 23 February 2020. These analyses are best presented with accompanying graphics and will be included in the full paper and the presentation.

A further objective of the trial was for Omni-Aware to demonstrate whether perception intelligence at an intersection could provide a Cooperate ITS (C-ITS) crash avoidance function in situations where the hazard was not equipped with C-ITS. During the off-road testing in September 2019, the Omni-Aware solution demonstrated strong performance in this area as well as more general functions:

- All test cases were satisfied in the off-road testing;
- Hazard identification by Omni-Aware was rapid (<0.2 seconds);
- Display of warning messages within vehicles occurred in 3-5 seconds (with opportunities to reduce this further identified); and
- The message data provided by Omni-Aware enabled the successful processing through Q-Free's standards-based interoperable C-ITS of the correct warning message with appropriate supporting information.

The trial also provided some general results as to the suitability of LiDAR sensors and the software developed by Omni-Aware as a perception approach for roadside applications:

- Spatial accuracy was very strong (errors of less than 10cm);
- The fidelity of LiDAR point cloud data was very high (clear surfaces were identifiable for objects such as pedestrians and vehicles);
- All road users (vans, cars, motorcycle, bicycle, pedestrian) were satisfactorily observed by the system; and
- Performance did not appear to degrade significantly in any observed environmental conditions (wind, rain).

## Investigating Driver Compliance with Road Rule 79A in Victoria

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### Abstract

The purpose of this project was to investigate driver compliance with Road Rule 79A (RR79A), which requires drivers to slow to 40km/h when passing a stationary enforcement/emergency vehicle. To investigate driver compliance with RR79A, a study was conducted involving a community survey, an on-road driver compliance study involving retrospective analysis of CCTV footage on a high-speed road and focus groups with emergency service workers. Awareness of the rule was high among community survey respondents, however their understanding of the circumstances in which the rule applies was far lower. Observed compliance was low, with less than 40% compliance across all emergency vehicles in the on-road study. Close following distance, non-compliance of other drivers, and limited visibility of enforcement and emergency vehicles were identified as major barriers to compliance.

### Background

RR79A commenced in Victoria on 1 July 2017. The policy intent of RR79A was to provide emergency and enforcement workers conducting duties by the roadside with additional protection from passing vehicles. The rule requires drivers and riders to:

- Approach a stationary emergency services or enforcement vehicle with flashing lights at a speed that will allow them to stop safely if required;
- Travel at a speed of 40 km/h or less at the point of passing a stationary emergency services or enforcement vehicle with flashing lights; and
- Not increase their speed until a safe distance from the scene.

Anecdotal reports from emergency workers identified variable compliance with RR79A as a major issue. Low compliance significantly reduces the effectiveness of the road rule, and potentially creates an additional road safety hazard in high speed environments. To address this issue, this project focused on generating an evidence base around driver compliance with RR79A in Victoria.

### Purpose and Description of Project

The aim of this study was to investigate driver compliance with RR79A in the Victorian setting. The approach used mixed methods (triangulation) to collect both qualitative and quantitative data. A community survey was conducted, which focused on awareness, attitudes and self-reported behaviour in relation to RR79A and involved a stratified sample of 400 current Victorian drivers. An on-road driver compliance study was conducted to directly observe behaviour in a real-world, high-speed road environment, and involved analysing video footage for 102 incidents involving around 24,000 passing vehicles. A series of focus groups obtained views directly from emergency service workers exposed to RR79A in their working environment, and included participants from fire, ambulance and police (emergency service workers).

## **Evaluation**

Most participants in the study (both focus groups and survey) supported the intent of the rule, however had concerns regarding complying with the rule in certain situations. Survey respondents felt that close following distance and noncompliance of other drivers around them were large barriers to complying safely with RR79A. Limited visibility of emergency vehicles was also identified as a barrier by survey respondents and emergency service workers.

Among community members surveyed, awareness of the rule was high (75%), but knowledge and understanding of the specific circumstances in which it applies was far lower (28% had limited understanding of under what conditions the rule applies).

Driver compliance was reported to be variable by the emergency service workers, and this was evident in the on-road observational study which found that compliance was lower for police (36%) compared to ambulance (76%) and fire (81%), and was lower in lanes further away from the emergency vehicle compared to the lane next to the emergency vehicle. Reported compliance in the survey was higher (60%) than the incidents observed in the on-road study (40% across all emergency vehicles), suggesting that drivers do not slow as much as they think they do.

## **Conclusion**

This study demonstrates that compliance with RR79A is sub-optimal in a high-speed environment and below the level of perceived compliance. Potential implications for policy and practice include fostering greater knowledge and understanding about required actions when interacting with an emergency vehicle in a range of scenarios and consideration of strategies that provide early warning for approaching drivers (e.g. improved conspicuity/markings of emergency vehicles).

## Motorcycling – high risk, but legitimate form of transport

Paul Graham <sup>a</sup>

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### Abstract

Motorcyclists still make up around 18% of all road deaths and serious injuries in New Zealand, despite representing less than 3% of road users, and make up a disproportionate share of ongoing health cost and trauma. In order to address motorcyclists themselves, a detailed analysis of recent crash data was undertaken, along with qualitative research among motorcycle riders, to understand the factors which might lead to a useful conversation with this target audience, by treating them as legitimate road users in a safe system.

### Background.

Compared to other high priority road safety areas, there has been little progress in reducing motorcycling deaths and serious injuries (DSIs) in New Zealand since 2010. In 2019, motorcyclists still make up around 18% of all DSIs, despite representing less than 3% of road users, and make up a disproportionate share of ongoing health cost and trauma. Each year since 2016 around 550 motorcycle riders are killed or seriously injured in crashes.

On average, the risk of being killed or injured in road crashes is 21 times higher for motorcyclists than for car drivers over the same distance travelled (Ministry of Transport 2014).

Many safety initiatives address other road users, asking them to “look out” for motorcyclists, who may be unexpectedly close, or small, or fast. However, in half of all fatal and serious motorcycle crashes on the open road, the motorcycle did not collide with another vehicle, so it has been important to develop messaging targeting the motorcyclists themselves.

### Method, Results and Conclusions

From New Zealand’s road crash database during 2012-2019, in 1778 fatal and serious collisions with another vehicle the motorcyclist had the primary responsibility for 55% of the open road crashes, but only 29% in urban areas (New Zealand Transport Agency 2019a). Culpable collisions with another vehicle were more often “head-on” or “loss of control/run off road” types of crashes. When the other vehicle had primary responsibility the crash types were more likely to be intersection or lane-changing types of crashes.

The crash evidence does not show that ‘returning riders’ are at any greater risk than other groups in the motorcycling population (New Zealand Transport Agency 2019b). Returning riders were counted as those who had held a motorcycle licence for at least five years, had not registered a motorcycle at least five years, and had registered a motorcycle in the past six months (Centre of Road Safety Intelligence 2013). However that population itself has aged with 85% of riders now 40 years old or more. Consequently while greater proportion of motorcyclist DSIs are being recorded for this group (54% of total motorcyclist DSIs), younger motorcyclists present the higher risk (15% of riders, but 46% of the DSIs).

In-depth qualitative interviews were conducted with a sample group of 12 less experienced motorcyclists, recruited from the New Zealand population of male 20-40 year olds who had held a motorcycle licence for less than 5 years, rode regularly on the open road, and rode a range of medium

and large, cruiser, sports and racer bikes. The insights gained helped to target our safety messaging to the motorcycling population in New Zealand (Glasshouse 2019).

For example, these riders all acknowledge that riding takes practice and they are always learning – they also acknowledge that it is important to buy the right bike for the individual and his/her ability – “It’s not a competition about power”, “You’re always learning, always improving, there is always something that can catch you off guard”.

Riding a bike is more than a mode of transport for this group – it is a lifestyle, even for the commuters. They take pride in their motorbikes, and often spend weekends either riding them or enhancing them – “Customisation of my bike takes up a lot of my time and research”, “Bikes are just part of my world. Everyone I know or talk to rides bikes”.

These riders feel excluded, singled-out and blamed as a minority form of transport, and think other road users don’t necessarily understand the rules, and therefore blame them for what are legal manoeuvres. They are treated like riding is a sport or risky hobby, not as a legitimate mode of transport.

The paper will report on the research, including audience testing, leading up to the development of new motorcycle messaging, and the reactions and feedback from the motorcycling community.

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## A Modernised Safe System Model

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<sup>a</sup>Road Safety Victoria, <sup>b</sup>Corben Consulting, <sup>c</sup>Safe System Solutions

### Abstract

While the safe system model has been active in Australasia for over a decade, jurisdictions have implemented it to varying degrees and with varying success. This model takes a holistic view of the road transport system and the interaction of various elements including roads and roadsides, travel speeds, vehicles, and road users. It aspires to create a road transport system where human mistakes do not result in death and serious injury. Traditionally, these four pillars have been represented as a circle with four quadrants with no clear explanation as to how each of these quadrants interacts with each other and functions within the system.

This paper discusses how the integration of the pillars can improve the implementation of road safety measures and the development of genuine 'system design'. This system design approach could enhance current geometric design guides and enable the elimination of harm over a set time frame.

### Background:

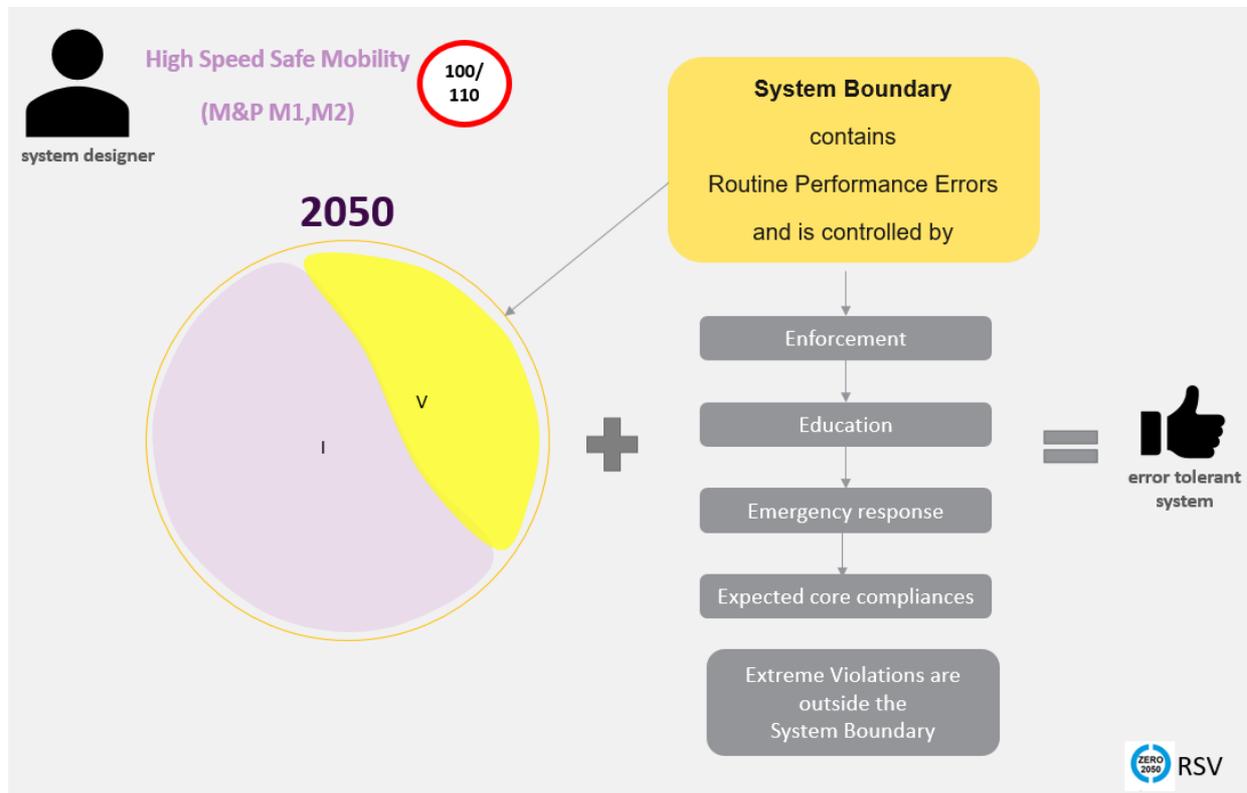
The Safe System Model has been active in Australasia for over a decade, during which time jurisdictions have implemented it to varying degrees and with varying success. The Safe System approach takes a holistic view of the road transport system and the interaction of various elements including roads and roadsides, travel speeds, vehicles, and road users. It aspires to create a road transport system where human mistakes do not result in death and serious injury. Traditionally, these four pillars have been represented as a circle with four quadrants with no clear explanation as to how each of these quadrants interacts with and functions within the system. It is widely accepted that a fifth pillar now exists which is referred to as 'emergency response'.

The work of Strandroth, Moon & Corben (2019), however, provides significant progress towards not only understanding the interactions between these pillars but also the practical integration of the five pillars for achieving long term trauma targets towards zero. It is a fresh interpretation and pragmatic approach towards integrated 'system design' that will enable jurisdictions and their road safety partners to eliminate harm over a set time frame. It has the potential also to form a 'safe system design domain' which, if so, does not replace the current geometric design guides but complements and enhances them.

### Findings:

By integrating mobility and human error, two relative constants in the application of system design, with infrastructure and vehicle technology, two relative variables in the application of system design, a modernised safe system model can be developed. In this system, road function (i.e., mobility) is typically determined for the entire road network by Movement and Place (M&P) outputs, from which energy levels are designed to forgive routine human performance error. While human performance error is unlikely to change significantly by

2050, the system is controlled by a system boundary (Newstead, 2018) of enforcement, education, emergency response, and expected core driver compliances such as wearing seat belts and not speeding excessively. The integration of the infrastructure and vehicle technology variables, however, can affect the mobility depicted by M&P. Figure 1 below provides an example of the integration of these elements.



**Figure 1**

In this example, high mobility requirements necessitate higher levels of infrastructure to manage the kinetic energy of crash forces while the attributes of the lowest standard vehicles in the fleet by 2050 provide substantial benefits. In time, the system boundary resource is foreseen to lessen as vehicle, infrastructure, and mobility are transformed to the point where routine human performance errors are tolerated without harm.

### Conclusion:

A modernised safe system model reflects the need to integrate the five pillars of the safe system approach into a practical and tangible application in design. At an operational level, this refreshed 'system design' will enhance current geometric design, and by integrating all pillars, will improve the application of safe system principles to eliminate harm from the road network.

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## Using Virtual Reality to Increase Awareness on Safe Interactions between Light and Heavy Vehicles

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<sup>a</sup>Deakin University, <sup>b</sup>City of Greater Bendigo, <sup>c</sup>Transport Accident Commission (TAC)

### Abstract

The first year of independent driving is associated with high crash and fatality rates. While there are a number of initiatives focusing on improving safety for younger drivers there remains little focus on safe interactions between light and heavy vehicles on our roads. This paper discusses the use of Virtual Reality (VR) to facilitate two different VR experiences involving interactions between light and heavy vehicles from a perspective that most drivers wouldn't typically experience. The first experience focuses on a heavy vehicle's safe braking distance and the second on the need for heavy vehicles to use two lanes when making tight turns. For each situation the participant experienced the same interaction as both a passenger in the light and heavy vehicles. Results show that participants were able to empathise with each of the drivers and gain increased awareness around safely interacting with heavy vehicles.

### Background

In 2017, the City of Greater Bendigo Freight Study highlighted that interactions between light and heavy vehicles are an important road safety issue (City of Greater Bendigo, 2017). In 2017, the NTARC reported that approximately 80% of heavy vehicle fatalities involving multiple vehicles were the fault of third-party drivers, approximately a quarter of these drivers were aged 21 or younger (NTARC, 2017). While there are road safety resources focussing on learner drivers including DriveSmart (Chapman and Wallace, 2018) and myLearners (VicRoads, 2021), there is limited coverage of heavy vehicles.

Virtual Reality (VR) provides the ability to immerse a user in a virtual environment and is beneficial in generating scenarios that are difficult to access or safely replicate. Virtual Reality Perspective Taking (VRPT) is a technique where users assume the role of a virtual avatar and it has been shown to increase empathy (Ahn, Bailenson, & Park, 2014; Seinfeld et al., 2018; van Loon, Bailenson, Zaki, Bostick, & Willer, 2018). This paper looks to use VRPT to increase the level of awareness around safe interactions between light and heavy vehicles through assuming the role of a virtual passenger in both light and heavy vehicles.

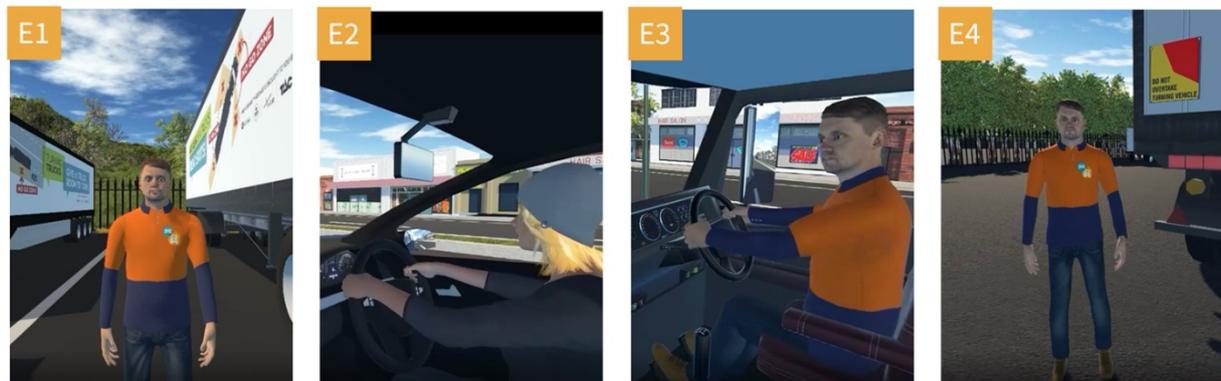
### Method

The two developed VR experiences, named *Season 1* (safe braking distance) and *Season 2* (two-lane turns), presents participants with on road situations from a perspective that few drivers would normally experience. Each season comprises four episodes and the first episode introduces participants to the heavy vehicle driver through conducting a heavy vehicle safety check. In episodes two and three, the participant is a passenger in the light and heavy vehicle respectively and experiences the same on-road interaction from both perspectives. In the final episode of each season the participant and heavy vehicle driver recap their experiences to discuss the shared responsibility of drivers and gain greater insight to the challenges heavy vehicle drivers face. Figure 1 provides an overview of the two seasons and views from the VR environment.

The VR scenarios were developed in close consultation with heavy vehicle subject matter experts including the decision to focus on safe braking distance and two-lane turns. To evaluate the effectiveness of the VR experiences, pre- and post-surveys were conducted to investigate if participants gained any new knowledge from undertaking the experiences.



Season 1 - Please Give Us Space (Heavy Vehicle Safe Braking Distance)



Season 2 - Why two lanes? (Heavy Vehicle Two Lanes for Tight Turns)

*Figure 1. Overview of VR Experiences*

## Results

A total of eleven participants, four male and seven females undertook pre- and post-surveys after completing season one of the VR experiences. Participants were asked whether they gained any new knowledge after undertaking the VR experience. Results show 82% (N=9) of participants acquired new knowledge showing that the VR experience resulted in increased awareness around safe interactions between light and heavy vehicles.

## Conclusions

This paper presents an approach to increasing awareness amongst younger drivers on safe interaction between light and heavy vehicles using VR. Results show an increase in the level of awareness around safe interactions between light and heavy vehicle perspectives with 82% of participants reporting the acquisition of new knowledge. Future work will look to evaluate the level of situational empathy participants gain after undertaking the VR experiences.

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# Detecting Road User Mode of Transportation using Deep Learning to Enhance VRU Safety in the C-ITS Environment

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## Abstract

This research aims to achieve the highest level of injury prevention by developing a deep learning approach to enhance Vulnerable Road Users (VRU) safety in the Cooperative Intelligent Transport Systems (C-ITS) environment. The proposed approach provides strong classification capabilities for transportation mode detection based on using the total linear acceleration data across 1-second monitoring for each reachable C-ITS entity inside the communication coverage.

The results on the validation set showed a binary classification accuracy of 93.04% when distinguishing between VRU (individuals Walking, Running, or Cycling), and Non-VRU (individuals in a Car or Bus). This accuracy decreases to 88.64% and 80.50%, based on four and five classes metric consecutively that can stratify VRU modality and demonstrates the difficulty of accurately distinguishing transportation by car and bus. The approach warrants further testing and may hold promise for future C-ITS development and efficient implementation.

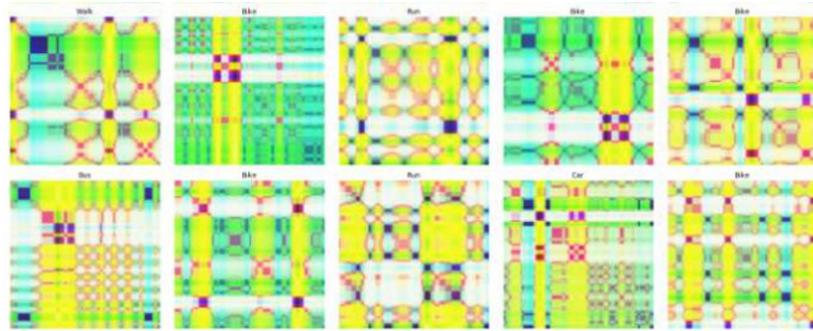
## Background

In recent years there has been a global effort to develop robust Cooperative Intelligent Transport Systems (C-ITS). Transport Certification Australia recognises that C-ITS should aim to improve safety and efficiency in the transport network. Equipping C-ITS with the ability to detect Vulnerable Road Users (VRU), such as pedestrians and cyclists, may be an essential strategy in the pursuit of a 'Towards Zero' road-safety approach. Many studies have sought to achieve this by applying machine learning methods to mobile-phone sensor data collected by road users, as discussed by Ashqar et al. (2019). These studies often show an improvement in classification accuracy over previous methods, but at the cost of increased complexity, requiring either larger time windows (e.g. 4-30 seconds) or the combination of multiple sensors (e.g. accelerometers, gyroscopes, rotation vectors and GPS). In this study, we pragmatically sought to create a method that would combine accuracy with efficiency, using only total linear acceleration and 1-second monitoring periods to provide strong classification capabilities.

## Method

Mobile phone sensor data was collected by researchers affiliated with the Virginia Tech Transportation Institute, as previously reported by Jahangiri and Rakha (2015) and (Ashqar, Almannaa, Elhenawy, & Rakha, 2019). Interpolation and pre-processing of the raw sensor data were performed in accordance with the original study. Total linear acceleration was then calculated and, using the approach proposed by Wang and Oates (2015), each 1-second window was transformed into a 3-channel image, examples of which are shown in Figure 1. Each colour channel corresponds to either the Gramian Angular Summation/Difference Field (GASF/GADF), and the Markov Transition Field (MTF), implemented in the *pyts* package (Faouzi, 2018). Images were randomly assigned to training and validation sets, comprising 80% and 20% respectively. The *fastai* v1 package was used (Howard & Gugger, 2020), providing a wrapper to PyTorch (Paszke, et al., 2019). Models were predominantly trained on a NVIDIA 1080 Ti GPU. Optimal learning rate was adaptively

selected using the cyclical learning rate approach proposed by Smith (2017). Using a ResNet34 architecture, various models were trained over a range of epochs.



*Figure 1. Example Showing 10 GASF-GADF-MTF Samples*

## Results

The best performing model was selected based upon results from the validation set. As set out in Table 1, using only 1-second spans of total linear acceleration data, the model achieved a binary classification accuracy of 93.04% when distinguishing between VRU (individuals Walking, Running, or Cycling), and Non-VRU (individuals in a Car or Bus). This accuracy decreases to 88.64% on a four classes metric that stratifies VRU modality. Under the five classes metric the accuracy drops substantially to 80.50%, demonstrating the difficulty of accurately distinguishing transportation by car and bus.

*Table 1. Results from Selected Model on Validation Set*

	Accuracy
<b>Binary Classes (VRU, non-VRU)</b>	93.04%
<b>Four Classes (Bike, Walk, Run, non-VRU)</b>	88.64%
<b>Five Classes (Bike, Walk, Run, Bus, Car)</b>	80.50%

## Conclusions

Just as the development of C-ITS should seek to improve both safety and efficiency, their implementation depends as much upon their accuracy as it does on real-world constraints. This study developed a novel method to classify road user mode of transport. Using only total linear acceleration data across 1-second windows, the approach achieved 93.04% binary validation accuracy when distinguishing between those road users that may be vulnerable and those that are not.

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## **Towards Zero Connected and Automated Vehicle Trial Grants Program – identifying road safety actions through public-private collaboration**

Joanne Vanselow<sup>a</sup>, Blake Harris<sup>a</sup>, James Soo<sup>a</sup>, David Young<sup>b</sup>

<sup>a</sup>Road Safety Victoria, <sup>b</sup>Transport Accident Commission

### **Abstract**

To achieve its longer-term vision of zero lives lost on Victorian roads, the Victorian Government's Towards Zero road safety strategy recognised the need to investigate future technologies' potential contribution to delivering this vision. To this end the Victorian Government allocated \$9 million to facilitate a trial of Connected and/or Automated Vehicle (CAV) technology on Victorian roads. The trials aimed to inform and support Victoria's readiness for these technologies in order to realise their potential safety benefits.

The CAV trial grant projects will be evaluated against the program's original purpose, and the value of the projects to the Victorian government will be assessed. The projects required industry and government collaboration to achieve the project goals. Partnership between government and private industry presents opportunities and challenges for both parties but fundamentally, closer ties allow for better understanding for addressing problems and generating solutions for public benefit.

### **Background**

There has been much interest in the opportunities for CAV technology to assist in achieving road safety outcomes. To investigate the potential of CAV technology, The Victorian Government allocated \$9 million towards facilitating a trial on Victorian roads. Three projects were selected for CAV Trial grant funding through a competitive Expression of Interest (EOI) process. The Department of Transport (DoT) received 22 formal submissions, these were evaluated against a set of criteria by subject matter experts and referred to an executive-level DoT/Transport Accident Commission (TAC) steering committee for a decision.

The three projects included a connected vehicle project led by a partnership between Telstra and Lexus Australia; a roadside installation of CAV sensor technology by a consortium called Omni-Aware; and the development of a Highly Automated Driving (HAD) system for rural highways, led by Bosch Australia.

### **Purpose of the Towards Zero CAV Trial Grant Program**

The scope of the program was to include real-world practical deployments of CAV applications and support systems that meet Victoria's Towards Zero Road Safety Strategy & Action Plan 2016-2020 priorities.

The main purposes of the program were to:

- Trial CAV technologies that will inform and support Victoria's readiness for CAV technology in order to optimise safety benefits leading to reduced deaths and serious crashes.
- Evaluate how CAVs may reduce road trauma to inform future investment and planning (infrastructure, roads and technology requirements).
- Generate knowledge that will inform government's future planning for infrastructure, roads design and CAV technology requirements that reduce road trauma.
- To spur the early deployment of CAVs that will reduce road trauma by providing a testing environment for on-road development of CAVs.

## **Evaluation and Effectiveness (Lessons Learned)**

The CAV trials have produced learnings around what constitutes a CAV-ready environment. This includes requirements for data, infrastructure, road design, telecommunications, positioning and regulation.

A full evaluation of the program will be available prior to the conference in September 2021 and will provide more detail on how the program has delivered against the EOI criteria. In addition, the program will be evaluated with respect to the value of the lessons learned for government, any challenges faced, and recommendations for future work.

## **Conclusions**

The road safety problem cannot be solved in isolation: it requires a community-wide response. The Towards Zero CAV Trial grants program highlights how government and industry collaboration helps navigate the boundaries between the public and private sector in their respective roles to deliver the state's vision of zero lives lost and reduced serious injuries. The CAV trials have allowed DoT and TAC to see beyond the hype of media releases and product launches to gain a deeper understanding of CAV technologies, their road safety potential, and the key role that government must play in enabling these technologies in Victoria.

## **Implications and Next Steps**

The Towards Zero CAV trials have raised further questions around Victoria's readiness for CAV technology. Further trials are required to encourage technology development in Victoria. The grant funding model allows risk to be minimized for government who can exercise some control over the funding, however it also presents challenges for providing certainty to industry regarding future funding beyond the life of the program.

## **Developing a heavy vehicles safety features roadmap in order to promote safer heavy vehicles beyond the basic legal requirements**

Michael Chan

### **Abstract**

Victoria Government has a large pipeline of significant infrastructure projects being delivered over the next 10 years. Amongst these projects are high value multi-year investments including Metro Tunnel, West Gate Tunnel, Railway Crossing Removals and North East Link. The majority of these infrastructure projects are being undertaken in the Melbourne central business district (CBD), highly populated inner suburbs on the fringe of the CBD, and metropolitan areas. Heavy vehicles are interacting constantly throughout the day with vulnerable road users on their way to and from the numerous project sites and its surrounding areas. The purpose of this heavy vehicle safety features roadmap is to promote safety beyond basic legal requirements.

### **Developing a heavy vehicles safety features roadmap in order to promote safer heavy vehicles beyond the basic legal requirements**

In the five years from 2014 to 2018, there were 90 pedestrians and 42 cyclists killed or seriously injured in crashes involving heavy vehicles in Victoria. FSIs involving heavy vehicles were found to be more common in Metro areas 56.8% than Regional 43.2% in Victoria. Throughout the lifecycle of an infrastructure build, adjacent road and curb side conditions change to accommodate the requirements of the build. Changes to road and curb side conditions can lead to confusion and compromised awareness of all traffic hazards by pedestrians and cyclists around construction sites.

To protect these vulnerable road users (VRUs), four mandatory minimum truck safety features were introduced in early 2018 into contracts of Victorian government and Transurban service providers. Service providers who use heavy vehicles to deliver services to or on-behalf of government and Transurban in major Victorian projects were required to have these four safety features fitted to their trucks. The heavy vehicle safety features relating to VRUs work by either improving the visibility of the driver, alerting vulnerable road users to the proximity and movement of the heavy vehicle, or by preventing VRUs from being trapped in the vehicle's undercarriage.

The purpose of this heavy vehicle safety features roadmap is to promote safety beyond basic legal requirements. This roadmap will be in part developed in conjunction with input from the construction industry. It will extend the setting of priority safety features into the contracts in a tiered manner to:

- facilitate practicable uptake of essential features for those suppliers who are not ready to replace their fleet but can retrofit the features, and
- incentivise market leading uptake of highly desirable features that can only be acquired as an inbuilt feature of the vehicle (e.g. low cabin) for those suppliers who are ready to commence their fleet replacement

This action is aligned with the National Road Safety Action Plan 2018-2020 for governments to investigate options to require improved heavy vehicle safety standards through their construction contracts. DoT has participated in the truck standards working group, comprised of internal and external stakeholders, and will lead the truck standards element of this action at the national level.

The roadmap will be a living document, whereby its protocols will be refreshed on a periodical basis to map the emerging safety features and the timing of their recommended uptake as an ongoing guide for contractors to plan their fleet acquisition and replacement. The methodology to establish the roadmap, identify the safety

features to set, and formulate the implementation approach (including audit and compliance management) will be included in this work. The roadmap will also provide a framework for heavy vehicle operators and companies to adopt to improve road safety across the industry and foster greater social responsibility, with the aim of saving lives and preventing serious injuries around major construction works in urban areas.

Once established, the roadmap will be promoted through Local Government and other jurisdictions to maximise the benefits of this investment and harmonise the safety obligations of government contractors.

## Estimating the effect of multiple combined interventions: the IILM

Paul Graham <sup>a</sup>

<sup>a</sup> New Zealand Transport Agency

### Abstract

The Integrated Intervention Logic Model (IILM) is a tool developed by the New Zealand Transport Agency (NZTA) in partnership with key road safety stakeholders to inform strategies aimed at improving safety across the network. The tool uses crash data and evidence-based research and models to estimate reductions in deaths and serious injuries (DSIs) based on a specific dose of each intervention working in synergy. It includes a baseline projection of deaths and serious injuries against which the impacts of the interventions can be estimated. Twelve interventions have been modelled to date.

### Background and Method.

The Integrated Intervention Logic Model (IILM) is a tool developed by the NZ Transport Agency (NZTA) in partnership with key road safety stakeholders to inform strategies aimed at improving safety across the network.

The tool uses crash data and evidence-based research and models to estimate reductions in deaths and serious injuries (DSIs) based on a specific dose of each intervention working in synergy. Its purpose is to understand the combined effect of road safety interventions taking a systems-based approach, rather than a more basic model that simply looks at the effectiveness of single interventions. It includes a baseline projection of deaths and serious injuries against which the impacts of the interventions can be estimated. Twelve interventions have been modelled to date.

The baseline projection was developed as a precursor to the development of the IILM, and has been presented previously (Morrison and Albuquerque, 2019).

A key objective of the IILM is to give greater assurance about investing in the right safety interventions in the right combination and at the right levels. It is more important to look at interventions as a package, rather than individually, as many of the interventions work synergistically. Users select a suite of actions and activities and prescribe the degree of each, and the tool calculates the cost and potential road casualty savings from that combination of interventions. The dependency, union, dominance or independent nature of the interventions are used in determining the combined effect.

The IILM also accounts for changes in effectiveness of an intervention over time dependent on the dose and the projected baseline casualties.

In its current stage of development, the tool includes at least twelve road safety interventions with known effectiveness:

increasing speed enforcement levels; reducing speed limits in urban corridors to 30 km/h; increasing the proportion of the motorcycle fleet equipped with ABS; removing 1 and 2-star rated cars from the vehicle fleet; undertaking speed management programmes on the highest risk segments of the road network; increasing the installation of median barriers; undertaking intersection treatments at the highest risk sites; increasing the number of red light cameras; undertaking a programme of low

cost, road and roadside treatments; increasing the roadside compulsory alcohol testing regime; improving the uptake of alcohol interlocks; and, expanding the speed camera programme.

Users can input the intended timeframe, their desired levels of each of the interventions to build a road safety programme, and adjust a number of the underlying parameters within the tool to suit their preferences such as current fuel prices or the estimates of the effectiveness of some interventions. The tool then generates an overall estimate of casualty reductions in the chosen timeframe and a broad estimate of the cost of the programme.

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## Using lidar data for analyzing road safety at an intersection – evaluation of the Omni-Aware data-set for road safety research

Joanne Vanselow<sup>a</sup>, Andrew Somers<sup>b</sup>, David Johnson<sup>b</sup>, David Young<sup>c</sup>

<sup>a</sup>Department of Transport, <sup>b</sup>Omni-Aware, <sup>c</sup>Transport Accident Commission

### Abstract

The Victorian Government has partnered with Omni-Aware to conduct a trial of technology to help improve road safety at intersections. Light Detecting and Ranging (LIDAR) sensors are often used by Connected and Automated Vehicles (CAVs) to perceive and navigate the road environment, however the Omni-Aware project takes LIDAR technology to the roadside to test its potential to bring the benefits to more road users sooner.

One intersection in Melbourne was equipped with LIDAR sensors at each corner, the point clouds were merged to produce a single dataset that can be used to identify road user movements through the intersection. The result is a rich dataset with huge potential for road safety research. This paper will describe the dataset including any limitations and assumptions. Road safety researchers can access this data by application to the Department of Transport.

### Background

The Victorian Government's Towards Zero Road Safety Strategy recognizes the important role technology will play in reducing road trauma over the long term. In order to better understand its potential, funding was allocated to support groundbreaking trials of new technology and to support its uptake. (Victorian Government, 2016) The Omni-Aware project aimed to adapt commercially available CAV technology to be used on roadside enabling more road users to benefit from the technology sooner.

The traditional approach to road safety analysis relies mostly on crash statistics and reports as the main source of data (Laureshyn, 2010). The Omni-Aware project has produced a new data-set to aid in understanding patterns and factors that contribute to crash and near-miss incidents, by collecting data from four LIDAR sensors installed on the four corners of an intersection in Melbourne. Intersections are a significant contributor to road trauma with 12% of deaths and 23% of serious injuries occurring at 60/70 km/hr intersections in Victoria. (Victorian Government 2016) Spatial constraints at many intersections limit the type of road safety interventions that can be applied and that is where technology may enable an alternative approach.

### Purpose of Project

The purpose of the project is to investigate a fresh approach to reducing road trauma at intersections. The project will identify whether CAV technology, adapted for the roadside, can be used to address road safety problems that are unable to be mitigated through other known road safety treatments.

### Description of the trial

Four LIDARs, four cameras and a high-powered computer (to process and store data) has been installed at the intersection of Williamstown Road and Somerville Road in Yarraville, in the inner-west of Melbourne.

The equipment was installed at the intersection in November 2019 and collected data from December 2019 until May 2020.

The data from the four lidars will provide a rich dataset that provides accurate data on the position, bearing, velocity and acceleration of all road users as they move through the intersection.

### **Intended Outcomes**

Omni-Aware will have collected five months of data from a busy intersection in Melbourne's inner-west by mid-2020. This paper will present on the dataset produced by the Omni-Aware system and any assumptions and limitations that will be important considerations for researchers interested in using this, or similar, datasets for research purposes.

At the time of writing, the data collection is still underway, with the project due for completion in mid-2020. There is no other dataset available of this type in Australia and therefore it presents a unique road safety research opportunity. The resulting dataset will be available for further road safety research beyond the end of the trial.

### **Conclusions**

The Omni-Aware project has produced a unique dataset that will allow for retrospective analysis of road user behaviour at an intersection in Melbourne. What makes this dataset unique is the richness of information that is provided as a result of using LIDAR sensor technology, and the extended length of time over which the data has been collected.

### **Implications and Next Steps**

The dataset is managed by Victoria's Department of Transport which encourages researchers to apply to use the data for road safety related research.

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## Darebin's Octopus School Pilot Program

Jennifer McIntyre<sup>a</sup>, Hannah Neumayer<sup>a</sup>

<sup>a</sup>Darebin City Council

### Abstract

The Octopus School program is a Darebin City Council initiative designed to increase the number of students actively travelling to school, along with decreasing congestion and improving road safety in primary school precincts. Council has been working directly with schools and the local community to manage travel to school issues for over ten years, including investment in school infrastructure through Walking, Cycling, Speed reduction, and Traffic Management capital programs, and externally supported programs such as Bike Ed, Walk to School and Fit 2 Drive.

Council developed an approach to work intensively with one school every year to complete four modules, which represent varying amounts on engagement from different stakeholders, culminating in the construction of road safety treatments funded by Darebin Council. The four modules assist the school with setting up a sustainable program of achievements to embed active travel behaviours across the community.

### Background:

The Octopus School program is the part of this broader work by Council on various transport and road safety issues around local primary schools, and includes input from the following:

- Council Report on Children's Crossings (2015)

In 2015, Council reported on the approach to children's crossings, which included upgrading crossings to raised crossing design. Our Transport Team now ensure any raised threshold crossings installed meet the requirements for becoming zebra crossings in the future, which may allow school crossings to function without a school crossing supervisor, should other conditions support this.

- *Safe Travel to School Audits (2011-2017):*

Council has been conducting Safe to School audits of local primary schools to build a list of priority locations for implementing road safety interventions. The highest priority recommendations have been implemented for 18 schools so far at a cost of approximately \$1.2 million (to 2017).

- *School Crossing Supervisor investigation:*

In 2017, Council developed a response to State Government's investigation into funding models for School Crossing Supervisors. As part of our submission we presented research on the current costs associated with supervised crossings, and the minimum Council spend to create 'safe school zones' that encompassed engineered road safety interventions.

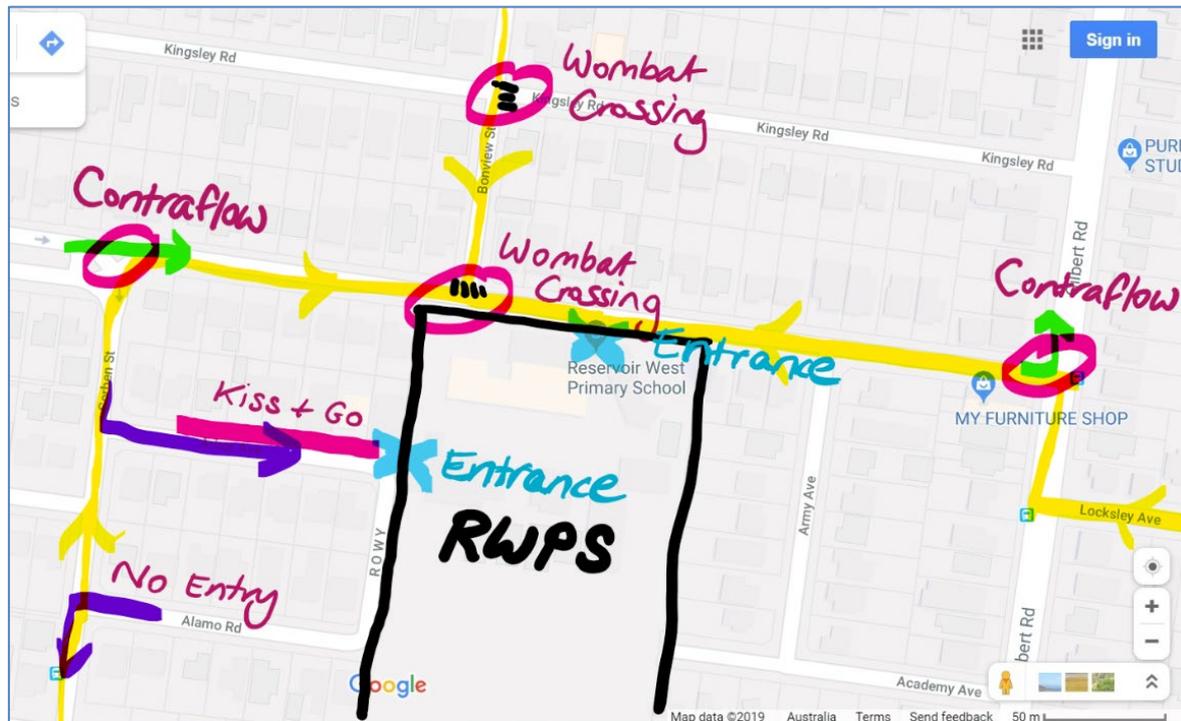
It was calculated that a minimum spend of \$500,000 per school would cover traffic calming on adjacent streets. Council, however, did not have a budget that high for each of its 46 schools, but committed to invest in developing the capacity of schools to also deliver programs that align with more participation in active travel. Thus was born the Octopus School Program. In our first year of the Octopus School program, Council was able to invest \$270,000, which highlights the need to use a safe system approach that doesn't rely solely on infrastructure, but includes safe people, safe speeds and safe vehicles.

### The program

As part of the application process, schools are asked to identify a local transport issue/s and the barriers they face in addressing it at a school level (Table 1). Commonly, vehicle congestion around

**Table 1. Interventions and activities**

	<b>Description</b>	<b>Image</b>
<p><b>Active Routes Mapping</b></p>	<p>Ground decals designed and installed highlighting the distance and time to walk or ride from approximately 40 locations along each route. Mapped in a brochure for families to use or view online.</p>	
<p><b>Road Decal Installation</b></p>	<p>Competition to design road surface decals to act as traffic calming.</p> <p>Four designs selected that represented the objectives of the program. Produced 1500x1500mm thermo decals, with approximately 40 applied to the road surface.</p>	
<p><b>Bicycle Parking</b></p>	<p>Design and installation of a 14m x 5m metre bike shed, to ensure students that chose to ride would have a safe, dry location to keep their bikes at school.</p>	
<p><b>Kiss &amp; Go No Parking Zones and Entry Changes</b></p>	<p>Trial a one-way loop during school pick-up and drop-off times</p> <p>Signs were installed banning entry at one street, resulting in the one way loop to encourage proper use of Kiss &amp; Go and minimise the risk of crash from students having to exit vehicles on the far side of the road</p>	
<p><b>Bike Fleet and Bike Ed</b></p>	<p>Procurement of a bike fleet (18 bikes) so students without access to their own bicycle, or who lived too far to cycle to school, could still participate in the Bike Ed program.</p>	



**Figure 1. Working design of road safety interventions**

peak drop-off and pick-up times are brought up, along with a perception from families that it is not safe to walk or use other modes of active transport when travelling to and from school (Figure 1). Using this information, the school is supported in developing active travel routes which are translated into a map for families, along with the following components to promote active travel:

- Road Decal Installation (technical issue – traffic calming)
- Bicycle Parking (technical issue – safe storage of bikes)
- Kiss & Go No Parking Zones and Entry Changes (technical issue – congestion and road safety)
- Bike Fleet and Bike Ed (social/financial issue – accessibility and education)
- Infrastructure (technical issue – road safety)

### **Conclusion**

The total project cost to date is approximately \$950,000. This includes design and construction of infrastructure at two schools, and design of infrastructure for an additional one this financial year, along with programs and materials valuing around \$80,000 per school for the three main Octopus Schools. Traffic counts post installation of the pilot school's infrastructure has shown a decrease in the vehicle volumes adjacent to the school.

# Darebin's Octopus School Pilot Program

Jennifer McIntyre  
Hannah Neumayer

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In 2015, Council reported on the approach to children's crossings, which included upgrading crossings to raised designs. Our Transport Team now ensure any raised threshold crossings installed meet the requirements for becoming zebra crossings in the future. Which may allow school crossings to function without a school crossing supervisor, should other conditions support this.

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#### The Program

As part of the application process, schools are asked to identify a local transport issue/s and the barriers they face in addressing it at a school level. Commonly, vehicle congestion around peak drop off and pick-up times are brought up, along with a perception from families that it is not safe to walk or use other modes of active transport when travelling to and from school. Using this information, the school is supported in developing active travel routes which are translated into a map for families, along with the following components to promote active travel.



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Procurement of a bike fleet (18 bikes) so students without access to their own bicycle, or who lived too far to cycle to school, could still participate in the Bike Ed program.



#### Road Decal Installation

Competition to design road surface decals to act as traffic calming. Four designs selected that represented the objectives of the program. Produced 1500x1500mm thermo decals, with approximately 40 applied to the road surface.

#### Kiss & Go No Parking Zones and Entry Changes

Trial a one-way loop during school pickup and drop-off times. Signs were installed banning entry at one street, resulting in the one way loop to encourage proper use of Kiss & Go and minimise the risk of crash from students having to exit vehicles on the far side of the road.

#### Bicycle Parking

Design and installation of a 14m x 5m metre bike shed, to ensure students that chose to ride would have a safe, dry location to keep their bikes at school.

#### Active Routes Mapping

Ground decals designed and installed highlighting the distance and time to walk or ride from approximately 40 locations along each route. Mapped in a brochure for families to use or view online.

## Using community feedback to complement road safety risk metrics

Jay Baththana and Haris Zia<sup>a</sup>

<sup>a</sup>Abley

### Abstract

In 2019 New Plymouth District Council (NPDC) completed district-wide consultation to gather feedback on road safety issues in the district under the assumption that locals know local roads best. Consequently, the New Plymouth district wide safety review tool was developed to explore the opportunity to use community feedback to complement commonly used road safety risk metrics. Typically, metrics such as Collective Risk and Personal Risk and more recently Infrastructure Risk Rating (IRR) have been used to prioritise road safety improvement projects in New Zealand. This new tool will enable practitioners the use of community ideas and concerns in prioritising road safety projects, ensuring an inclusive decision-making approach.

### Background

The New Plymouth district wide safety review tool was developed to combine community feedback, IRR (a risk measurement based on the physical environment) (NZ Transport Agency, 2016) and crash history to inform future road safety improvement projects in the district.

### Community Feedback

New Plymouth District Council (NPDC) reached out to the local communities to hear their opinion on road safety issues in the district with the assumption that locals know local roads best. A total of 1,093 responses were received where various issues related to infrastructure and road user behaviour were raised. These issues were categorised into walking, cycling and driving and the results were published on a web map accessible to the general public. Following this initial stage, the data was shared with Abley for further analysis.

### Tool Development

The geospatial road centreline that formed the base for NZ Transport Agency's Safer Journeys Risk Assessment Tool (Mega Maps) (Durdin et al., 2016) was used as the base road network. This was to provide practitioners the ability to easily link this analysis with Mega Maps analysis by using the same unique identifier. Spatial analysis was used to combine community feedback, crash history and risk metrics to the road centreline. In addition, proximity to school data was included in the analysis as improving safety around schools was considered a high priority by NPDC. Hence, corridors that provided direct access to schools were given a higher weighting.

### Corridor Prioritisation Tool

Corridor prioritisation was done based on the combination of road safety risk metrics (IRR, Collective Risk and Personal Risk), community feedback and proximity to schools. These four key parameters were weighted as such to ensure a more proactive site selection approach (IRR and Personal Risk were given a higher weighting). The spreadsheet tool enables any user to test different weightings to see what impact this has on risk classification across the district. Each community feedback issue category weighting can also be changed to test the overall impact. For example, congestion may be given less priority than speeding in developing a road safety improvements programme. The spreadsheet includes all the input columns for calculating risk, including the IRR attribute categories.

The spreadsheet tool was also set up so that changing one (or more) input(s) can alter the overall risk score, to see the benefits of those changes on overall risk. This includes the ability to change the IRR inputs (e.g. roadside hazard risk).

### **Findings**

The analysis presented a methodology to combine community feedback and road safety risk parameters to better inform safety initiatives. Including community feedback in the decision-making process supports a collaborative approach and provides practitioners a tool to support/ oppose any community driven road safety proposals.

### **Next Steps**

The tool offers a number of opportunities for further development to better inform NPDC's road safety improvements program. If community feedback is collected periodically; the tool could be used to monitor the road safety risk/ community feedback relationship. The tool will also be a great resource for future stakeholder engagement and consultation. Currently a low-cost option of linking the spreadsheet to a web map with dynamic update capabilities is being investigated.

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## **Injury while drink walking in public places: comparison of patterns associated with vehicle collisions and falls**

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<sup>a</sup>Centre for Accident Research and Road Safety-Queensland (CARRS-Q), Queensland University of Technology (QUT)

### **Abstract**

Drink walkers are at high risk of collision with vehicles, however they are also at risk of falls when using footpaths and related public places, an issue of greater relevance in the current context of promotion of active travel alongside the move Towards Zero. Differences in drink walking and injury patterns were investigated using 10 years (2008-17) of Queensland Injury Surveillance Unit data. Preliminary results show that pedestrian falls are six times more common than vehicle collisions, while drink walking comprises a larger percentage of falls cases (9.0%) than collisions with cars (5.5%) or motorcycles (5.9%). In contrast, males are more highly represented as drink walkers in collisions with cars (82.5%) than falls (63.3%). Together with age differences, the results point to a need to focus on pedestrian infrastructure on footpaths and related areas to reduce falls risk, and exploration of the contribution of differences in spatial and temporal exposure.

### **Background**

Walking while intoxicated is a risk factor for pedestrian collisions with vehicles (Hezaveh & Cherry, 2018). Intoxicated pedestrians are also at risk of non-collision injuries such as falls (Woods, Jones & Usher, 2019). Intoxicated pedestrians who are struck while crossing a road are a subset of all pedestrians injured while walking intoxicated, so a comparison between these groups may provide information on risk factors for intoxicated pedestrian collision with vehicles. At a strategic level, the move Towards Zero coincides with a widely shared aim to increase active transport, a link which is more definitively stated in the Sustainable Development Goals (UN General Assembly, 2015). A better understanding of the patterns of injury associated with drink walking could inform urban design and drink walking countermeasures.

### **Method**

As part of a wider project on pedestrian injury in Queensland, ten years of injury data (2008-2017) was provided by the Queensland Injury Surveillance Unit (QISU). The QISU data is entered on an electronic form or manually on a standard form by Emergency Department staff in a number of hospitals around Queensland, including most major hospitals.

Injury descriptions were scanned for all pedestrians (as classified by the Queensland Government), to identify drink walking (“intoxication”) cases. To address code misclassification of pedestrian data (Karkaneh et al., 2012), variables including mechanism of injury, activity while injured and nature of injury were manually inspected and recoded.

Mechanisms of injury were categorized as “pedestrian single” events (e.g. fall) or “pedestrian partner” events when another agent was involved (e.g. collision with vehicle). At this stage preliminary descriptive data has been produced; multiple calculations of relative risk will be conducted using Medcalc (ref) to compare the two largest groups (falls and collisions with cars) using predictors such as gender and age for injury characteristics, body location and type of injury.

## Results

Table 1 provides a brief summary of some of the data. There were 8,354 cases; 7,120 (85.2%) were single pedestrian events, of which 6,869 (96.5%) were falls; 1,234 (14.8%) were pedestrian partner events, of which 1,146 (92.9%) involved collision with a car. The proportion of pedestrians injured in falls who were drink walkers was 9.0%, higher than the proportion struck on the road by cars (5.5%), bicycles (0%) and motorcycles (5.9%). Drink walkers struck by cars were more likely to be male than those in falls (82.5% vs 63.3%).

**Table 1. Preliminary descriptive data, injuries while drink walking on roads or in public places, QISU-reporting hospitals, Queensland 2008-17**

		N	N (%) Intoxicated (denominator 10+)	Of intoxicated, N (%) male
<b>Pedestrian single events</b>	Falls	6869	619 (9.0)	392 (63.3)
	Other	251	14 (5.6)	8 (57.1)
<b>Pedestrian partner events</b>	Vs car	1146	63 (5.5)	52 (82.5)
	Vs bicycle	26	0 (0)	0
	Vs motorcycle	17	1 (5.9)	1
	Vs mobility device	2	1	1
	Vs e-mobility device	1	0	0
	Assault	29	9 (31.0)	8
	Vs animal	3	1	0
	Vs other moving object	2	0	0
	Vs other	8	1	0

Other results (not included in Table 1) show an interaction between age group and drink walking, with drink walkers under 18 years old being more likely to be struck by cars compared with falls, and drink walkers aged 60 and above being more likely to be injured in falls.

## Conclusions

Falls are far more common than collisions with vehicles, suggesting that a focus on pedestrian infrastructure off the road would have significant safety benefits as well as supporting active travel. The proportion of drink walkers was also higher among pedestrian falls than among pedestrian collisions with vehicles, although for this result, and the sex and age differences reported, further exploration is needed to account for temporal and spatial exposure differences.

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## Over Speeding and Road Safety in Bangladesh

Mohammad Mahbub Alam Talukder<sup>a</sup>, Md Asif Raihan<sup>b</sup>

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### Abstract

Over speeding is one of the major causes of road traffic crashes in Bangladesh. Heavy vehicle drivers violate the speed limits frequently even at the crash prone locations of the highways. The main objective of this study was to investigate the potential causes of over speeding that triggers the crash probabilities. Questionnaire surveys followed by an in-depth interview were conducted at different heavy vehicle bus and truck terminals of Dhaka city from July to December 2018. While researching the reasons behind over speeding, it was found that saving time (37%), and carrying more passengers and quick delivery of goods (14%) were the triggering factors. Other significant factors were driving at free flow speed (17%) whenever possible, escaping from police harassment (10%), earn more thus making more trips (13%), and overcoming the time lag from congestion (9%). A combined public-private initiative is thus essential to address the over speeding related crashes on the highways in Bangladesh.

### Background

Road traffic crash is a major but neglected public health challenge in Bangladesh. Bus and truck drivers violate traffic rules while driving on highways is a well-known fact. Furthermore, increase in driving speed is related to the probability of crash occurrence and the consequent severity. Therefore, this study aimed to find out the potential causes of over speeding that increases the chance of heavy vehicle crashes in Bangladesh.

### Method

The study integrates questionnaire survey which was conducted at different heavy vehicle bus and truck terminals of Dhaka city, which connects the major cities of Bangladesh, from July to December 2018. The socio-demographic data were collected from randomly selected 500 statistically representative drivers through the semi-structured questionnaire. In addition, 14 drivers were selected for in-depth interview.

### Results

The reasons of over speeding are multifaceted; the main reasons are saving time, carry passengers and goods quickly to the destination, avoid police harassment, overcoming the lag time from traffic congestion, and to earn more within working hour. Furthermore, about 13% drivers mentioned that they never violated the speed limits; while, 28% admitted that they often violated speed limits. However, 59% bus and truck drivers replied that they usually did the speeding when they could avail free flow speeds.

### Conclusions

It was agreed by the participant drivers of the heavy vehicles that speed is the single most important cause for the heavy vehicle related crashes in Bangladesh. The findings of this study are quite self-explanatory in the sense that these point out the areas where emphasis should be given to overcome the problem. Indeed, the solutions are engineering, such as, safe road; education, such as, training, drivers' award programs; and enforcement, such as, strict laws.

## **Examining group dynamics: involving community people towards safer road**

Mrinmoy Samadder, Turzo Nicholas Mandol

James P Grant School of Public Health, BRAC University, Dhaka, Bangladesh

### **Abstract**

Road accident is considered as one of the leading causes of death in recent years. In Bangladesh, roads are nothing but killing machines which ranked it first among the South Asians countries. Besides all the initiatives taken organizing small groups at the community level to reduce road accidents across rural areas in Bangladesh is a pressing priority. Several NGOs undertook different initiatives in achieving road safety and reducing fatalities in roads. Following Tuckman's model, this paper analyzes the relevance of group dynamics and the effectiveness of CRSG (Community Road Safety Group) as a model for ensuring road safety based on six different groups which were intensively studied in different stages of qualitative research method. Due to lack of group coordination actions taken for reducing road fatalities was less effective. Recognizing the group's effort in attaining road safety, incessant interrelations, inspirations, and supervisions can only sustain it's success and functions.

### **Background**

In recent years, road accidents are considered as the leading cause of death both in the developed and developing countries. In Bangladesh, the situation of road accident has become worse in compare to other countries across the world. Here roads are considered as killing machine. The ongoing skill improvement and awareness training, courses, workshop from Govt. and non-govt. have not reduced the march of death. In these backdrop, BRAC has intervened a group named community road safety group (CRSG) to create a consensus and develop strategies for proper usage and safe accident free road. The paper analyzes the relevance of group dynamics and effectiveness of CRSG as a model for ensuring safety road.

### **Methods**

The four stages of Tuckman's group dynamic model was applied to investigate the activities, performances and contribution of the group over the years. Six cases were intensively studied in different phases of research. Qualitative methods were executed to collect data (Data for this study were collected using Qualitative methods). To understand the capacity of the group members in making the safety environment of road users, socio-demographic information were gathered by conducting survey in the initial stage of group formation. Interviews, case studies, meetings observations and Focus Group Discussion (FGD) were administered in different stages of data collection following the adopted model of group dynamics of this study. Data was collected considering the aspects of both group and the individual level.

### **Results**

Findings explored that the members who are middle age, a certain level (secondary) of education and have political affiliation can easily communicate to the local Govt. officials, law enforcing agencies and fulfilled their desired demand on safer road. Few individual performances were observed which had also significant influence on group activities like, poster making and producing leaflet. Vibrant presence of group helped to protect road carpet from destruction. Illegal three wheel vehicle stations were eloped by their activities. Stoppage are fixed in places and public followed the rules. Instructions of road use are disseminated into household level which helped to abide by the law of usage road.

## Discussion

Mobilisation of group members in different phases successfully contributed in protecting lives of road users. Two third of the members were found to be responsible to participate meetings, followed by decisions. But as a member of group, few members lack integrity which often produces group isolation. Finally, CRSG as a group gained popularity among the community by their functional activities. Group and individual performances helped to recognize a dynamic platform for group productivity and self-identity.

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## **Impact of Community Reaction on Mildura Council's Speed Reduction Project in Residential Streets**

Christopher Ivan Davis

Mildura Rural City Council Mildura, Victoria, Australia

Aiming to improve community safety and livability, in 2015 Mildura Rural City Council (MRCC) embarked on a review of speed related safety on 1,000km of its sealed road network. This paper analyses the impact of community reaction while providing an overview of the project.

The review included collection of AusRap and ANRAM data, commissioning a review of all project area speed limits, to make new speed reduction recommendations, and validate through community consultation acceptance of the proposed recommendations.

Broadly, the review recommended 40 km/h in all residential streets. Three randomly selected focus groups unanimously supported the recommendations. However, during construction there were unexpected negative print and social media attacks on council and its staff, predominantly focused on construction of the island thresholds, and not on the reduced speed limits.

The consultation learnings explored in this paper could assist practitioners to plan community consultation in their speed reduction programs.

### **Background**

A review of safety of MRCC roads followed a 2014 spike in fatalities and ongoing community complaints regarding speeding motorists. Council engaged Australian Roads Research Board (ARRB) to supply ANRAM and AusRAP analysis its 1,000 km sealed road network.

In 2016 Safe System Solutions were appointed to deliver a review of speeds limits on Mildura's roads. Considerations included road condition, primary function, traffic volumes, ANRAM and AusRAP ratings, FSI, and consultation to verify community acceptance of the review's recommendations.

The Speed Limit Review (Review) findings recommended adoption of new baseline "default" speed of 40 km/h in Mildura and 80 km/h in its surrounding towns. The Review also considered the road network's functionality allowing for conditional raising or lowering of limits. For example in Mildura 40 km/h would apply on all roads with the exception of:

- Collector roads (50 or 60 km/h)
- Laneways (10 or 20 km/h).

### **ANRAM validation**

To validate the Review's recommendations, ARRB re-visited the original ANRAM and AusRAP data, replacing the algorithm's original speed limits with proposed speed. ARRB predicted a 36% FSI reduction. AusRAP 1 and 2 star roads, which originally made up 70% of the network, reduced to less than 40%.

### **The project cost and activities**

Following a successful \$2,100,000 funding bid and council contribution of \$900,000, civil works commenced on the 40 km/h project in 2019. The projects activities included 40 Area speed zones, 313 LATM threshold treatments, two roundabouts, ten pedestrian crossings, 20km/h speed limit on CBD lanes, and two 10 km/h CBD shared zones. With strong verification from the focus group

feedback and other community consultations, the media team mostly focused on potential social media questions regarding speed limit reductions.

The frantic pace of the twelve month construction period and the sudden change in road infrastructure caused many drivers angst that was displayed through Facebook and the local newspaper. Comments mostly focused on the new threshold islands and their road narrowing design. However there were no complaints or negative feedback regarding the reduced regulatory speed limit.

### **The cost to staff**

Relentless social and print media attacks took their toll over the course of the project. Despite compelling evidence that delivering the speed plan will have great safety outcomes, at times social media feedback was savage and personal, and even named a senior manager. There were a total of 270 comments, with only a handful positive and self-moderating. The rest caused serious reputational damage and emotional tension to the council and the project's staff. Notwithstanding that the cost to staff is subjective and not quantifiable, a portion can be accounted as the time taken to: read the comments on social media, feeling the mental strain, de-stressing, discussions in the team and responding to those comments. The self-reputational damage of the staff is inexplicable and may even result in losses greater than our understanding. This had an impact on the quality time spent on daily works thus reducing the productivity of the entire project team.

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- 

The council couldnt find anything else to spend there money on so traffic islands i is....

Like · Reply · 34w
- 

No wonder ya don't hear about any of our councillors being at a brothel. Thats cause none of em could organise a [redacted] in one.

Like · Reply · 34w · Edited
- 

Another waste of rate payers money by the council. They have got the gall to increase our rates. Overpaid jokes that have no idea. This level of bureaucracy should be eliminated.

Like · Reply · 34w
- 

Was shaking my head as soon as they started popping up.90% of them are brainless.

Like · Reply · 34w
- 

Who was the REAL beneficiary of these ridiculous traffic islands .they wouldve been tendered out ..hope everyone hits MRCC with damage bills... Nobody asked we the people if we wanted them

Like · Reply · 34w

- 

They are a joke!  
 Local buses and even council trucks drive over then to get into side streets!  
 Executive decision made by someone behind a desk that has no bloody idea what's going on in the real world!

Like · Reply · 6w
- 

Biggest waste of money this side of the wave pool

Like · Reply · 6w
- 

Who's responsible for the idea I think the people deserve to know who is making such poor decisions and wasting money on our behalf so we can make the decision or not on whether they have a job or not

Like · Reply · 6w
- 

One of the biggest waste of money resources yet , good old Mildura leading the way for how to piss money in the wind

Like · Reply · 6w

Figure 1. Facebook and Print Media Comments

## **Developing a marketing strategy to increase Victorians' vehicle safety awareness and influence purchase decisions towards safer vehicles**

Danilo Messias<sup>a</sup>

<sup>a</sup>Road Safety Victoria, Victorian Department of Transport

### **Abstract**

Vehicle safety technology has seen a dramatic advancement in the past decade. However, not all models available to consumers offer the same level of safety content. Vehicle buyers tend to take safety for granted and are generally unaware of the latest technologies. Safety is usually a low-ranking factor in purchasing decisions. This paper discusses findings from a study commissioned by the Victorian Department of Transport to address current gaps in vehicle safety awareness.

The research combined the power of behaviour research, data analytics and strategic marketing techniques to develop the new Victorian Government's marketing and communication strategy for vehicle safety through an evidence-based approach. Findings from the research are used to deliver targeted, compelling and cost-efficient messages to increase vehicle safety awareness and influence consumers to prioritise safety in their purchase decisions.

### **Background**

There are substantial differences in the safety performance of different vehicle models. While some models offer little more than the minimum safety standards required by regulation, other models offer improved crashworthiness and other life-saving technologies.

Previous studies demonstrated that consumers are generally unaware of differences in vehicle safety level. They typically take vehicle safety for granted and are unlikely to consider safety in their purchasing decision process<sup>1</sup>. When it occurs, buyers often merely confirm that the chosen model has a 5-star rating. Knowledge of safety features also varies significantly according to demographic categories<sup>2</sup>.

### ***Method, Results & Discussion***

The study consisted of three streams to collect data for a gap analysis.

The first stream is an audit of vehicle safety campaigns delivered by road safety agencies in the past five years. The audit documents content, target audiences, campaign duration, media mix and intended behaviour changes. It identified road user groups that were not properly targeted.

The second stream is a road safety risk profile. The study uses Victorian crash data from five years to identify the most at-risk groups according to demographic characteristics.

The third stream is an in-depth study of public perception of vehicle safety. The objective is to understand the level of awareness, motivators, purchase habits, attitudes and behaviours of different road users. Community focus groups, followed by an online survey, collected data according to key demographic characteristics. In-depth interviews with key stakeholders and industry associations captured the specific needs of specialised groups of the population.

The data collected was consolidated, cross-linked and examined according to demographic characteristics. The result is a gap analysis informing the current situation compared to an ideal

scenario where consumers are informed of differences in vehicle safety and actively seek safer vehicles.

The main conclusions of the study were that:

- Young drivers, driving vehicles older than 15 years and living in regional areas are the highest crash risk group
- Older drivers and residents of Outer Melbourne are secondary at-risk groups
- Price is by far the first consideration when buying a car, however, drivers recognise the importance of safety
- Young Victorians believe to be knowledgeable about vehicle safety, but when examined at a deeper level, this knowledge is shown to be superficial
- Most drivers rate their driving capability as above average
- Family is the primary source of information to young Victorians looking to buy a car

Based on those conclusions, some recommendations placed were:

- Vehicle safety campaigns must be complemented with specific policies that facilitate access to safer vehicles by making them more affordable, particularly for at-risk groups
- Safety must be portrayed as affordable for any budget
- Vehicle safety message should never question a driver's ability to drive. Instead, it must be portrayed as "protection from other bad drivers"
- Targeting vehicle safety message at parents to influence young drivers to make safer vehicle choices.

The result is expected to guide Victoria's future vehicle safety campaigns and road safety policies.

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## **Consignors of import containers play a critical role in preventing heavy vehicle rollover, but they're often unaware of their role.**

Daniel Brain

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### **Abstract**

Significant on-road incidents involving container-laden heavy vehicles are 36% more likely to result in rollover, compared to vehicles carrying general freight (NTI, 2018). A common causal factor in these incidents is load shift within the container, causing the vehicle to become unstable and roll while navigating bends or turns. Loads inside containers shift due to inadequate packing and restraint. Incident data suggests that container packing is not being sufficiently prioritised by the supply chain, and container-laden heavy vehicle rollovers continue to occur due to packing deficiencies.

While the issue exists across all container movements in Australia, import containers tend to be highly represented in the data. The volume of container imports to Australia is forecast to double by 2029 (BITRE, 2019. BITRE, 2014). With >80% of container trips to/from Australian ports completed by trucks (BITRE, 2019), addressing container packing deficiencies in import containers is an essential step towards zero.

### **Background**

Heavy Vehicle National Law (HVNL) in Australia imposes a primary duty on each party in the supply chain to ensure, so far as is reasonably practicable, the safety of the party's transport activities. This requires parties in the supply chain to understand the risks involved in the transport task and do everything within the party's power and influence, "so far as is reasonably practicable", to ensure the safety of the task. An inherent element of the primary duty is that each party's ability to influence or control a certain risk can be different. Certain risks are commonly managed by multiple parties in the chain, with each party contributing to the risk management process in different ways. Rather uniquely, the ability for many parties in the chain to control the risk of deficient packing in import containers is removed by the nature of the task.

The party with the most ability to control container packing deficiencies is the container packer ('packer' is a named party in the HVNL). However overseas parties are outside the reach of the law, so there is no legal duty on overseas packers to ensure the container is packed appropriately. This issue is compounded where the safety standards in the country of origin do not match those in Australia.

Drivers often check loads at point of pickup, and often drivers have a large degree of involvement in the loading of their vehicle. Import containers pose a unique set of challenges for drivers. Firstly, port precincts are designed for efficiency and throughput so facilities for drivers to inspect containers seldom exist. Secondly, to effectively inspect container packing the container often requires full or partial unloading to gain sufficient visibility of the entire load. Thirdly, customs and biosecurity protocols often mean that containers cannot be opened within container terminals.

When it comes to effective container packing in import containers, the consignor often has the most influence and control. A consignor's risk controls therefore should include:

1. Development of evidence-based packing standards specific to the freight being loaded.
2. Communication of the packing standards to the overseas packer, preferably in the local language.

3. Requirement that the packer sends progressive photos of the loading process before authority is given to close and seal the container.
4. Inspection of containers on arrival to monitor the effectiveness of, and compliance to, the packing standard.

Without these critical risk controls in place, the safety of the transport task cannot be *ensured*, and other road users' lives are placed at risk. This was the case in a 2012 incident where a 33 year old father was killed after a container-laden heavy vehicle rolled onto the car he was operating. The investigation found that inadequately packed building materials had shifted inside the container as the heavy vehicle navigated a bend, which caused the vehicle to roll. A NSW court found the directors of Futurewood Pty Limited guilty of an offence as the consignor of the container (*Notaro v Futurewood Pty Limited*, 2015). No charges were brought against the driver or transport company in that court case.

## Conclusion

Consignors play a critical role in managing the rollover risk of container-laden heavy vehicles however are often not aware of their obligations, or how to effectively acquire them. Generating awareness of the risk and the controls consignors need to consider is essential to eliminate container-laden heavy vehicle rollover, and an important step towards zero.

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## **Can I have your attention please? Piloting an outcome evaluation on pre-novice driving youth aiming to determine the 'bstreetsmart' impact.**

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### **Abstract**

Road deaths and serious injuries among young novice drivers remain unacceptably high. They are among the most vulnerable road users in Australia; drivers 16-19 years are 6-8 times more likely to crash than those 55-59 years. Crash/injury prevention action must be multi-pronged to address the multiple factors influencing novice driver behavior and their willingness to engage in risky driver behavior. Bstreetsmart is a road-safety program targeting around 25,000 pre-driving youth across NSW annually. Despite increasing attendance, no formal outcome evaluation has previously determined the programs impact on pre and post knowledge and attitudinal changes. Engagement with this age demographic is historically challenging. Using pre-post survey methods, a smart-phone based app, teacher engagement, participation incentives, we surveyed 2630, 1000 and 178 students' pre, post and 3 months post-event respectively. Despite poor response fractions, attitudinal change was significant immediately post, with some sustained at 3 months. Full results will be presented.

### **Background**

Road deaths and serious injuries among young novice drivers remain unacceptably high and a serious public health issue. They are among the most vulnerable road users in Australia; drivers aged 16-19 years are 6-8 times more likely to crash than those aged 55-59 years. Young novice drivers worldwide have extremely high crash+/-fatality rates immediately post-licensure, highest in the first year.

Injury prevention action must be multi-pronged to address the multiple factors influencing novice driver behavior, including parental/peer influences, age/maturity, knowledge/attitudes, motivation and sensation-seeking. These factors impact involuntary and voluntary risky driver behavior; highly challenging when developing effective countermeasures. Initiatives in recent years include graduated licensing scheme, parental involvement<sup>2</sup>, education/training, legal enforcements, and interventions such as bstreetsmart.

bstreetsmart is an injury prevention program encouraging safer road-user behaviors among NSW youth. Annually, ~25,000 pre-driving youth witness crash re-enactments and potential risk-taking consequences, engage in interactive displays and learn injury/death prevention strategies at this event. bstreetsmart has undergone several 'process evaluations'; however, its capacity to influence the future behavior of the adolescents transitioning into driving adults remains undetermined. The aim of this study was to determine primarily the extent to which this large, teen demographic could be engaged using a web-based smartphone app and study participation incentives, in order to understand their risk profile more thoroughly, and whether the bstreetsmart event could impact this.

### **Method**

The proposed project will introduce the study app to all September 2019 bstreetsmart attendees, prior to the event (via their sign up schools), with an electronic study information pack. Consent will be set-up within the app itself, with data privacy assurance and ethics approval. Attending students will also be given the option of downloading the app and signing up on the day. Participants were incentivised with a chance to win one of 3 brand new iphoneXS and movie vouchers. Teachers were

incentivised with science incursions to inform their students of the study. Full HREC approval was obtained for a comprehensive profile of participating students. The NSW Education Research department however, removed significant amounts of this content in order to approve this study.

## Results

Incentivising with offers of iphones as well as attendance pre-event on all 3 days significantly aided recruitment pre-event (~10.5%). SMS blasts post event however, only retained 38% of this original cohort, and at 3 months post a mere 7%, despite further incentives, messages and emails. Despite poor response fractions, attitudinal change was significant immediately post, with some sustained at 3 months. Students were more likely to be risk averse if parents demonstrated safer road behaviors. Full results will be presented.

## Conclusions

While study design restrictions placed significant limitations on data received, the greatest imposition to research conduct in this demographic appeared to be sustained engagement. Greater resources and more novel 'youth friendly' methods may increase study participation rates. The bstreetsmart event has a significant attendance, and is able to demonstrate immediate impact on this age group. Further study is required to understand if this is sustained.

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## Glare safety problem in tunnels and underpasses in Australia

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### Abstract

High Luminance variations experienced when entering and exiting underpasses may cause severe crashes due to the occurrence of glare and the black-out effect. In this study, we propose a methodology using dynamic solar reflectors to minimise the high light variations that arise over a short distance at the underpass endpoints. First, a field investigation was conducted in one underpass in Brisbane, Australia to capture High Dynamic Range Images from the Field Of View of drivers to analyse their visual experience. Then, Radiance simulation engine was used for advanced conducting advanced glare analysis on the underpass 3D model, and Grasshopper was used for parametric modelling of the dynamic solar reflectors which aimed to reduce the luminance contrast. These reflectors were optimised to smooth the sharp transition between the maximum and minimum luminance experienced at these locations. Results showed the effectiveness of the proposed method in reducing the contrast level.

### Background

According to the recent research report, published by Austroads, identified glare is usually considered one of the critical safety problems [1-7]. This happens due to disability glare and black-out effect when entering and exiting tunnels and underpasses. Additionally, Boyce [7] emphasized the safety measurements and risks for drivers resulted from the ‘black holes’ at entrances and ‘white holes’ at exits from underpasses or tunnels because of the high contrast of luminance. This can have a negative impact on the driver sight (i.e. a significant eye pupil adjustment) when approaching the tunnel and underpass endpoints. In general, glare can cause vital safety issues for both human drivers as well as the Automated Vehicles (AVs), leading to sudden disengagement of autonomous systems in a critical driving moment [8].

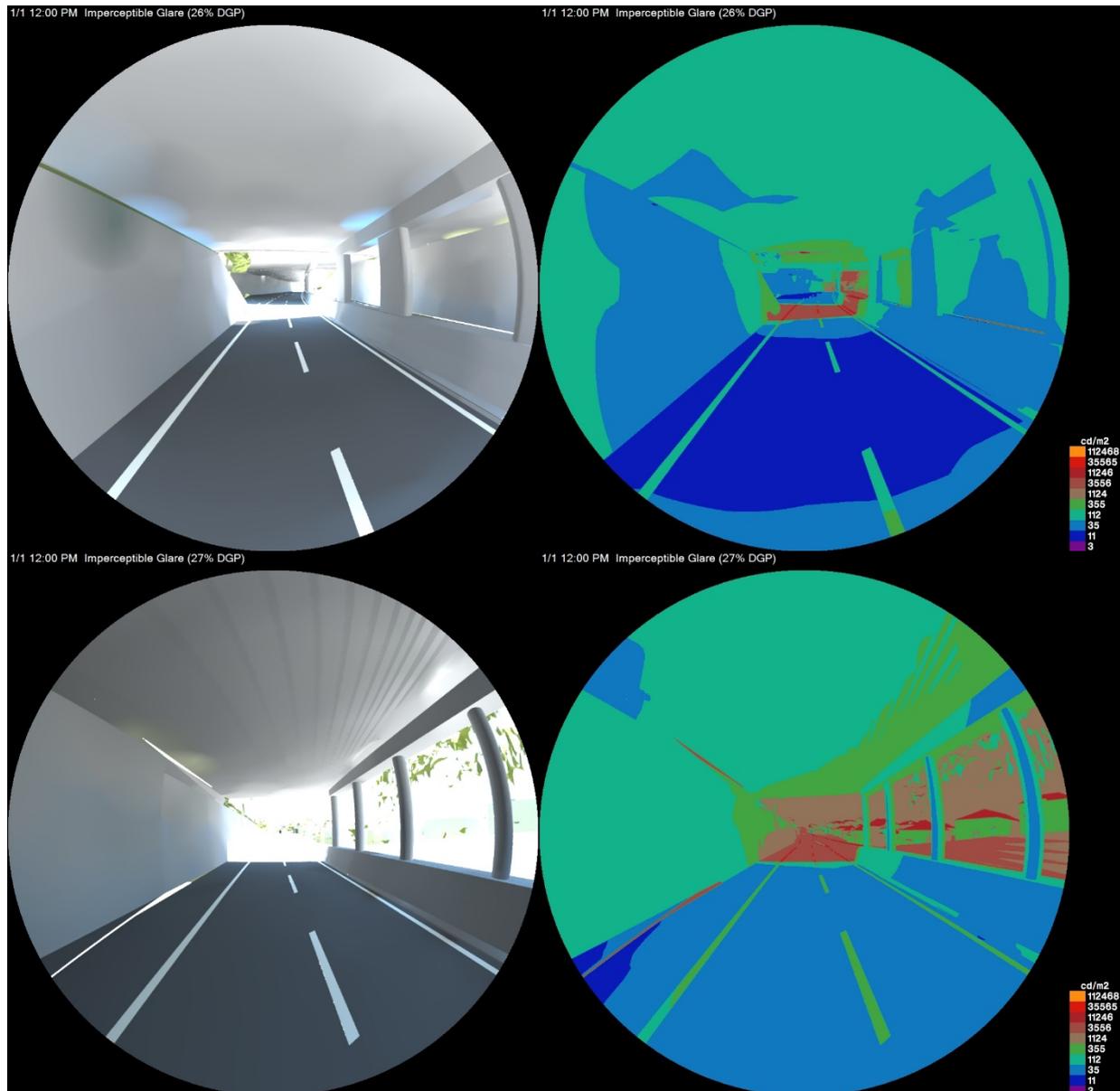
The main objective of this study is to increase road safety by reducing the number of potential crashes that can because of glare:

- 1- Identify the critical locations and times over the year when road safety problems may occur due to the variations in light levels.
- 2- Develop a realtime glare control system that changes the solar reflector configuration depending on the time of the day and season.

### Method

Thus, we propose a methodology to minimise glare at the entrance and exit of the tunnels aiming to reduce the probability of crashes. A case study in Brisbane, Australia, is selected where significant contrast exists between the dark interior of the tunnel and the bright illuminated environment outside, as shown in Figure 1. At the tunnel’s endpoints, we will test the use of dynamic solar reflectors [9] to reduce the luminance contrast found in these areas and to make the luminance levels in accordance with the visual adaptation rate [10]. The methodology is divided into three stages. In the first stage, we explored the available point cloud data from ELVIS to get access to the 3D point information of a tunnel or underpass in Brisbane. 3D modelling and simulation techniques were used to estimate the daylighting levels. High Dynamic Range images were simulated from the Field Of View (FOV) of

the drivers to calculate the spatial contrast and glare severity based on luminance maps generated. Grasshopper, which is a parametric tool for Rhino 3d modelling software, was used to model the underpass from the point cloud. Then, parametric variations of the solar reflectors were created and simulated using Diva for Rhino [11].



**Figure 1.** A section of M3 Inner City Bypass (ICB) underpass on the right and The luminance analysis on the right.

**Results**

At the tunnel endpoints, Glare problems are usually found due to the high contrast ratio reaching up to 1:140. The new transitional zone reduced the contrast level between the dark interior inside and the high illuminated outside to the adaptation rate of the eye.

**Conclusions**

This research will provide tunnel designers and operators essential knowledge to decrease the potential traffic accidents caused by glare. Moreover, the final design can be used as a guideline for engineers to design better underpasses and tunnels.

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## Can specific child restraint design features improve correct use?

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### Abstract

Ergonomic and user-friendly design features are thought to facilitate correct use of child restraints. Despite attempts at intervention, incorrect use of child restraints is widespread, and the optimal design of a child restraint to minimise incorrect use remains unknown. This body of work, comprising of three studies, aims to investigate whether targeted child restraint design can increase correct child restraint use. Incorrect use arising from errors introduced by both the child and parent/carer was investigated using naturalistic and laboratory studies. These data show that differences in child posture, belt positioning, comfort and error rates exist between restraints of varying design. To date, one specific design feature was found to be effective in reducing adult user errors during installation tasks involving the vehicle's seat belt. Together these preliminary results suggest restraint design changes have considerable potential to increase the correct use of child restraints.

### Background

Correct use of a child restraint (CR) requires the restraint to be installed in the car and used by the child exactly as the manufacturer intended. While there is evidence that some recent interventions can have a positive impact on errors in CR use (Hall et al., 2019; Keay et al., 2013; Koppel et al., 2013), rates of incorrect use remain high (Brown et al., 2010). To date, no interventions have specifically targeted restraint design. Yet previous laboratory and driving studies (Andersson et al., 2010; Fong et al., 2015; Osvalder et al., 2013) have demonstrated a significant relationship between CR design and child-related misuse and seating postures, and observational studies have noted a relationship between CR types and parent and child induced misuse (Brown et al., 2010). These findings suggest that CR design may be a good target for intervention to reduce errors in use.

This paper presents preliminary results from a body of work that aims to identify design-based solutions that target the ergonomics and user-friendliness of CR across both child and parent/carer sources of incorrect use.

### Method

Study 1 used naturalistic driving data to examine associations between CR design, and child travel behaviour.

Study 2 assessed the relationship between CR design features with comfort, child induced error, belt fit and child posture during a trip. A novel method for assessing child comfort, the Discomfort Avoidance Behaviour (DAB) rate, was also validated in a real-world setting.

Study 3 used a laboratory-based randomised controlled trial (RCT) to evaluate the effectiveness of a novel CR design feature in achieving a correct and secure restraint installation.

## Results

**Study 1:** There were significant associations between CR design features and a child's head and harness/seat belt position during everyday family travel. Specifically, the torso wing depth of both a forward-facing CR and booster seat was significantly associated with head position and harness/seatbelt use.

**Study 2:** Children seated in a booster seat (BS<sub>2</sub>) with no sidewings, sash routing guide or adjustable head rest recorded a higher DAB rate compared to a high-back booster (BS<sub>1</sub>) with these features (BS<sub>2</sub> = 2.79 vs. BS<sub>1</sub> = 1.85,  $p = 0.009$ ) and an increased DAB rate was associated with an increased number of child-induced errors ( $\log(\text{errors in use}) = -2.07 + 0.57 \times \text{DAB}$ ,  $p < 0.0001$ ). Children in BS<sub>2</sub> with no side wings were more likely to sit with back and shoulders against the backrest (BS<sub>2</sub> = 79% vs. BS<sub>1</sub> = 61%,  $p = 0.003$ ), and head against the headrest (BS<sub>2</sub> = 48% vs. BS<sub>1</sub> = 25%,  $p = 0.005$ ).

**Study 3:** The presence of a design feature specifically targeting belt-related error reduced belt error frequency from 2.35 to 1.3 ( $p = 0.042$ ) and a 'serious belt error' from 70% to 30% of installations ( $p = 0.011$ ). However, no significant difference in other types of errors were observed between restraints.

## Conclusions

Targeted CR design may be an effective way to increase correct use of child restraints and work continues to define an optimum set of design features.

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## Using in-depth accident data to identify limitations when applying crash injury risk curves

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### Abstract

Injury risk curves outline the relationship between speed and the risk of high severity outcomes for certain crash configurations, and hence are a convenient tool for road infrastructure design practitioners when assessing the safety of certain road designs. However, aggregation of data used to create these risk curves can hide important complexities that limit their usefulness. The aim of this study is to contextualise such risk curves with respect to other determining factors of crash injury severity. In-depth crash investigation data from the Initiative for the Global Harmonisation of Accident Data (IGLAD) database is used to compare the predicted risk of high severity outcomes with actual severity outcomes of crashes. The results of this study suggest that the risk of high severity outcomes was either under- or over-predicted for a substantial proportion of crashes within the database.

### Background

The relationship between speed and injury severity is well-known in the field of road safety (Woolley et al 2018). Injury risk curves are being used to inform the risk of high severity outcomes for certain common crash configurations (e.g. Wramburg 2005, Bahouth et al 2012, Jurewicz et al 2015). These injury risk curves have more recently been incorporated into design tools specifically targeted towards road infrastructure design practitioners (Jurewicz et al 2017). The attractiveness of using such risk curves lies in their simplicity of concept and application. However, an over-reliance on the aggregation and simplification of otherwise complicated real-world events can limit the ability for practitioners to be properly informed of the risks inherent in designs based on these speed-injury risk relationships. In this study, in-depth crash investigation data is used to identify and detail some of the variability in crashes that can affect crash severity and the relationship between speed and injury risk.

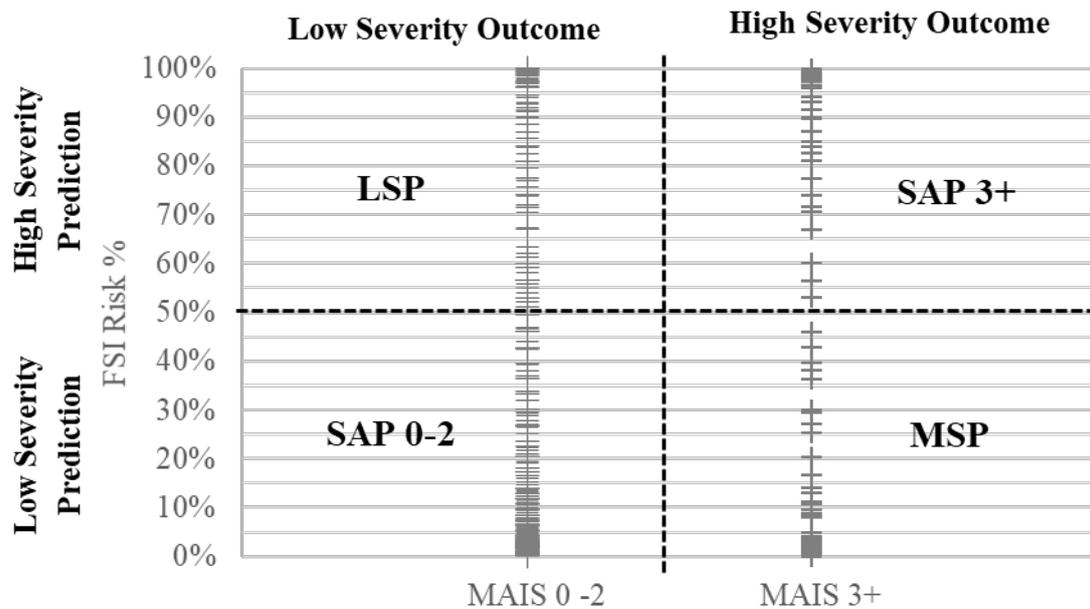
### Method

The aim of this study is to identify and detail crash factors that can affect crash severity and the relationship between speed and injury risk. The outcomes of this study are used to inform the limitations of applying injury risk curves to real-world design.

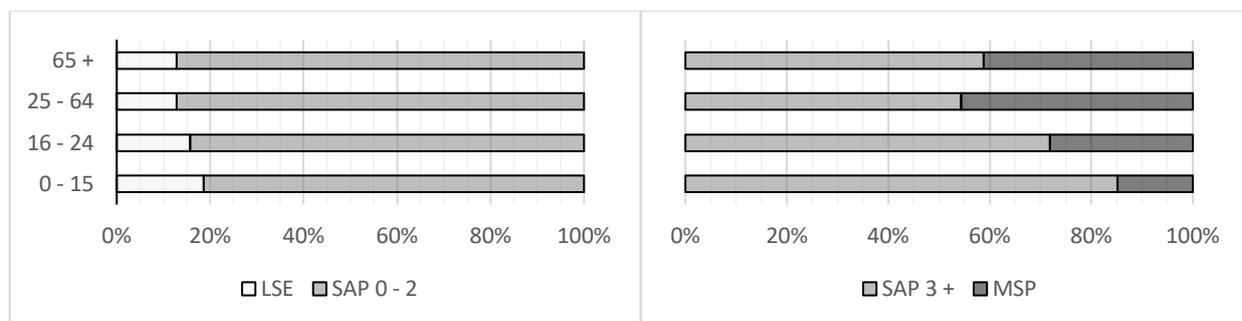
Speed, injury severity and crash factors are identified from a sample of crashes contained in the Initiative for the Global Harmonisation of Accident Data (IGLAD) in-depth accident database, which features data manually obtained by investigators at road crashes in Australia and internationally. The risk of high severity crash outcomes is estimated by applying speed information obtained through IGLAD to contemporary injury risk curves (e.g. from Bahouth et al 2012 and Jurewicz et al 2016).

No means of direct comparison are available between crash severity (the actual crash outcomes) and crash injury risk (the risk of obtaining a certain severity outcome). Instead, crashes are categorised based on the correlation between outcome severity and the predicted risk of high severity outcomes.

Three categories are used: crashes where there is good alignment between the crash severity and predicted risk of high severity outcomes (severity as predicted, SAP); crashes where the crash severity is high (maximum abbreviated injury scale, MAIS, is three or above) and the predicted risk of high severity outcomes is below 50% (more severe than predicted, MSP); and crashes where the crash severity is low (MAIS below three) and the predicted risk of high severity outcomes is above 50% (less severe than predicted, LSP). Crash factors are then analysed over the three categories to inform which may lead to increased or decreased crash severity compared to the predicted risk of high severity outcomes.



(a)



(b)

**Figure 1. (a) Designation of Less Severe than Predicted (LSP), as Severe As Predicted for low (SAP 0-2) and high (SAP 3+) severity outcomes, and More Severe than Predicted (MSP) crash data, and (b) Bar graph representing the proportion of LSP, SAP, and MSP cases for varying age groups**

**Table 1. Percentage of crashes with LSP, SAP 0-2, SAP 3+, and MSP for varying categories.**

Category		Data Count	MAIS 0-2		MAIS 3+	
			LSP	SAP 0-2	SAP 3+	MSP
<b>Occupant Age (years)</b>	<b>0 - 15</b>	205	19%	81%	85%	15%
	<b>16 - 24</b>	409	16%	84%	72%	28%
	<b>25 - 64</b>	1280	13%	87%	54%	46%
	<b>65 and older</b>	282	13%	87%	59%	41%
<b>Delta-V difference*</b>	<b>under 0.5</b>	421	13%	87%	52%	48%
	<b>0.5 – 2</b>	1175	14%	86%	69%	31%
	<b>above 2</b>	441	8%	92%	55%	45%
<b>Mass difference**</b>	<b>under 0.5</b>	385	5%	95%	22%	78%
	<b>0.5 – 2</b>	1547	16%	84%	63%	37%
	<b>above 2</b>	333	11%	89%	60%	40%
<b>Vehicle Year</b>	<b>1970 - 2000</b>	506	18%	82%	70%	30%
	<b>2001 - 2010</b>	1338	12%	88%	59%	41%
	<b>2011 and older</b>	460	9%	91%	38%	62%

\*Proportional difference in Delta-V of target vehicle compared to bullet vehicle.

\*\*Proportional difference in mass of target vehicle compared to bullet vehicle.

## Results

Preliminary findings show discrepancies between actual injury severity of crashes and the predicted risk of high severity outcomes. Preliminary analysis suggests crash factors that deviate between categories include occupant age, difference between delta-v values of vehicles in multi-vehicle crashes, mass differential between vehicles/participants, and year of manufacture of vehicles.

## Conclusions

In this study, the limitations of applying injury risk curves to practical design is investigated with the use of in-depth crash investigation data. Findings from this study will help to better inform practitioners of such limitations and the considerations required to overcome them.

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# Crashes Classification in Naturalistic Driving Scenarios Using Random Forest Machine Learning Algorithm

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## Abstract

This research analyses the viability of utilising observed kinematics in machine learning models to identify safety critical events (SCE's). There is a need for efficient algorithms to identify SCE's in large datasets, such as naturalistic driving studies (NDS). Typical threshold approaches, while fast, often fail to distinguish between normal driving and SCE's. The methodology proposed presents strong evidence that kinematic features used in machine learning models have good classification capabilities.

Three approaches were used to analyse 100-car NDS observations: trigger threshold approach (TTA) and two machine learning methods, single point random forest model (SPRFM) and time-shift random forest model (TSRFM). The TSRFM model performed the best, followed by SPRFM and TTA respectively. The results showed that these machine learning methods can better classify crashes and non-crashes than conventional trigger threshold approaches.

## Background

Naturalistic driving studies have become more prevalent due to their ability to overcome problems associated with traditional driving data collection techniques (Regan et al., 2012). These studies, most notably SHRP 2 (Antin et al., 2011) and VTTI 100-car experiment (Dingus et al., 2006), require a participant's vehicle to be equipped with a data acquisition system (DAS) which continuously records data. This has provided large collections of rich data that ranges from participant drowsiness to interactions with other road users.

Kinematic threshold approaches have been used as a screening process to identify SCE's in NDS datasets (Hankey et al., 2016). Video verification typically follows to confirm whether a SCE has occurred. Recently, kinematics observed from NDS have been used as features in machine learning algorithms to great success, with models consistently yielding high classification rates for SCE and baseline driving scenarios (Osman et al., 2019). This study produces initial insights into ongoing research which is targeted at improving classification rates of machine learning using observed NDS kinematics as features.

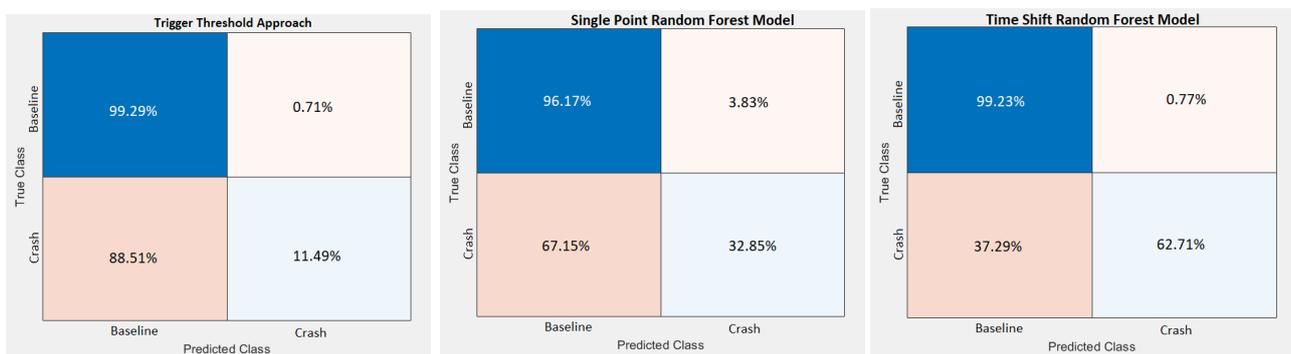
## Method

Crash kinematic data collected in the 100-car experiment by affiliate researchers from Virginia Tech Transport Institute (VTTI) was used for this study (Dingus et al., 2006). Epochs were considered to be baseline events if they occurred at least 1 s before an identified SCE for each trip (N = 242,375). Epochs were identified as SCE's if they occurred during an incident time window specified by VTTI (N = 46,288). Three approaches were considered: TTA, SPRFM and TSRFM. The SPRF approach considered each epoch as a potential baseline or SCE. SCE's in the TSRFM model had a time horizon equal to the SCE duration and were shifted back half this duration. The horizon was then shifted one epoch until the number of epochs shifted totalled the SCE horizon. The mean of each shift was then calculated. Each baseline instance in the TSRFM was calculated as the mean of the preceding five shifting epochs. The data was divided into testing and training sets using ten-fold cross validation. A random forest classifier was imported from the *sklearn* package in python with 100 trees and default parameters. Six features were used in the model: longitudinal acceleration, latitudinal acceleration, longitudinal jerk, yaw rate, swerve and speed.

## Results

The results from ten-fold cross-validation using a random forest classifier with 100 trees were compared using confusion matrices. The SPRFM model correctly identified 96.17% and 32.85% baseline and SCE's respectively. This result was improved to 99.23% and 62.71% for the time-shift TSRFM. In comparison to trigger threshold approach, which yielded 99.29% and 11.49%, these machine learning methods demonstrated the ability to better distinguish crashes from typical driving events.

The best performing approach was determined by analysing confusion matrices produced from classification. The TSRFM outperformed both SPRFM and TTA significantly, with high true positive values for both baseline and SCE's as seen in Figure 1. In comparison to the standard TTA, the TSRFM and SPRFM far surpass TTA's ability to distinguish between baseline and SCE scenarios. These results also highlight that improvements can occur in the current machine learning models, given that TSRFM only had a 62.71% crash classification rate.



**Figure 1.** Confusion Matrix Results for TTA, SPRFM and TSRFM approaches to 100-car experiment data classification

## Conclusions

Utilising observed kinematics as features in machine learning models has been proven to improve classification of SCE over threshold approaches for conventional vehicles. By using a random forest algorithm, both single point and time shift approaches outperformed kinematic trigger thresholds. These results are the beginning of ongoing research into the use of machine learning algorithms for NDS.

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## Safe System Infrastructure Innovation in Victoria's Safer Roads Program

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### Abstract

Safe System infrastructure development progressed significantly during the past five years. Most of this development has been delivered through practitioner-led innovation.

This abstract describes progress on several Safe System infrastructure innovations undertaken by Safer Roads program funded by Transport Accident Commission (TAC). These innovations include trials of signalised intersection platforms, rural side road activated intersection speed limits, compact roundabouts, and cushioned pedestrian crossings. Future innovation potential of additional designs is also discussed.

The presentation will showcase how TAC-funded infrastructure innovation is expanding Safe System implementation and practitioner design choices.

### Background

Genuinely Safe System infrastructure has been limited to several design solutions, e.g. roundabouts, raised pedestrian crossings, and flexible safety barriers. These are proven to minimise impact forces so that death and serious injury are unlikely for targeted road users. Agencies funding and implementing Safe System infrastructure created strong demand for new knowledge and solutions in recent years.

TAC funds Safer Roads program delivered by Department of Transport (DoT). The program's objectives seek to maximise Safe System implementation and practice in a cost-effective manner. Thus, program funding and direction enabled DoT practitioners to develop innovative road infrastructure solutions more closely aligned with Safe System outcomes than conventional options.

This abstract describes progress on several Safe System infrastructure innovations funded by TAC, e.g. signalised intersection platforms, compact roundabouts, cushioned pedestrian crossings and rural side road activated intersection speed limits. Future innovation potential of new designs is also discussed. TAC-funded infrastructure innovation is expanding the range of Safe System investment opportunities and solutions available to practitioners.

### Safe System Infrastructure Innovations

TAC and DoT staff work together to plan, develop and implement road improvement projects targeting key Towards Zero road safety strategy areas (VicRoads 2013). At times, existing design solutions are not adequately aligned with the Safe System objectives of the program. With TAC funding and encouragement, DOT staff have progressed innovation in several key areas of practice.

Initially, innovation was carried out ad-hoc based on initiative and skills of individual staff. Over time, clearer innovation management focussed on immediate and strategic Safe System infrastructure needs. In parallel, technology trials were carried out to create new data sources, strengthen evaluation and improve business intelligence (not covered here in detail).

Table 1 presents five targeted Safe System infrastructure solutions being progressed in Safer Roads program.

**Table 1. Innovations in Safe System infrastructure**

Solutions	Example	Application	Safe System alignment
<p><b>Signalised intersection platforms</b></p>	 <p>Source: Department of Transport (2019a)</p>	<p>≤60 km/h urban roads</p>	<p>High for vehicle occupants – impact speeds 30-40 km/h *</p>
<p><b>Compact roundabouts (rural)</b></p>	 <p>Source: VicRoads, unpublished</p>	<p>High speed rural roads, any mobility function</p>	<p>High for vehicle occupants – impact speeds 30-40 km/h</p>
<p><b>Compact roundabouts (urban)</b></p>	 <p>Source: Davis (2017)</p>	<p>Low speed urban roads (≤ 60 km/h), low-medium mobility function</p>	<p>High for all road users – impact speeds 20-30 km/h</p>
<p><b>Cushioned pedestrian crossings</b></p>	 <p>Source: Nearmap (2020)</p>	<p>Low speed urban roads (≤ 60 km/h), low-medium mobility function</p>	<p>Moderate for pedestrians and cyclists – impact speeds 30-40 km/h</p>
<p><b>Rural side road activated speed limits</b></p>	 <p>Source: VicRoads unpublished</p>	<p>High-speed rural roads, medium-high mobility function</p>	<p>Supporting Safe Speeds pillar</p>

\* Severe injury (MAIS3+) impact speed thresholds based on Woolley et al. (2018).

Development of each of these solutions requires several innovation stages:

- Problem definition and prioritisation,
- Ideation and concept development,
- Funding and resourcing
- Pilot / trial execution
- Evaluation
- Development of DoT engineering guidance and its dissemination.

Table 2 shows the progress of the above System infrastructure innovations undertaken by Safer Roads.

**Table 2. Progress towards Safe System practice**

<b>Solutions</b>	<b>Pilots and trial evaluations</b>	<b>Safe System guidance development</b>
<b>Signalised intersection platforms</b>	First and second trials evaluated for speed changes under several design variants on 60-70 km/h roads.	Initial guidance published (Department of Transport 2019a). Lessons from the second trial evaluation yet to be incorporated.
<b>Compact roundabouts (rural)</b>	Pilot at one site in 2017, follow-up monitoring completed. A follow up trial is in planning.	Initial guidance development in progress.
<b>Compact roundabouts (urban)</b>	Trialled at several sites in Mildura completed in 2017. Evaluation completed.	Yet to occur.
<b>Cushioned pedestrian crossings</b>	Effects of speed cushions known from published literature. Several sites delivered since 2017, no evaluation planned.	Yet to occur.
<b>Rural side road activated speed limits</b>	Initial trials completed and the follow-up trial is under evaluation.	Technical specification has been published (Department of Transport 2019b).

Some solutions require a two stage approach: first a pilot or a small trial evaluation is funded to test fundamental Safe System benefits and any risks. If proven successful, a second larger trial and evaluation can be delivered via a funded treatment program on the basis of estimated severe injury savings. Typically, the second trial has an objective of testing broader application scenarios, refining guidance and/or refining Safe System benefit estimates (often based on Safe System proxies such as speed, conflict analysis). Long-term evaluations of actual severe injury prevention effectiveness are planned using crash data some years after treatment.

Safer Roads is considering additional Safe System infrastructure innovations to tackle difficult strategic safety problem areas. These include development of additional / alternative Safe System design solutions for:

- Vehicle occupants at at-grade intersections on  $\geq 70$  km/h urban arterials
- High-speed intersections on rural motorways to replace the conventional solution
- Highly-effective flexible barrier applications in urban conditions.

## Conclusions

TAC funding of Safer Roads program enabled DoT staff to undertake a program of Safe System infrastructure innovation. As shown by the selected examples, this is leading to increased number of

Safe System design solutions which can be funded to minimise severe injury on Victorian roads. New guidance provides improved Safe System design choices for practitioners.

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# Enhancing Road Safety Knowledge and Practice around Rural School Zone in Cambodia

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## Abstract

Cambodia has seen a rapid increase of almost 500% in its road traffic over the last 10 years with 88% of those newly registered vehicles being motorcycles. Together, limited enforcement and improvement of the safer road engineering has led to increasing speeds resulting in more frequent serious crashes along both the national and local community road networks. Farmers, workers and students continued to be the high-risk groups of road traffic crashes contributing to 76% of total road crash fatalities in 2018. Speeding was the main cause of road crash fatalities (38%), and 68% of those were motorcyclists<sup>1</sup>. On average, at least 5 people died and 11 more were seriously injured on Cambodia's roads everyday, creating enormous impact on the social and economic welfare of the country with an estimated annual cost 400 million US\$, representing about 2% of the country Gross Domestic Product (GDP)<sup>2</sup>. Adopting the national road safety action plan that aligned with the UN Decade of Action for Road Safety 2011 – 2020, road crash fatality was forecasting to halve by 50% aimed at saving 7,350 lives<sup>3</sup>. This study examines practices, measures and approaches implemented via global, regional and country sustainable best practice. Observation and assessment on community challenges, experience, socio-economy, culture, understanding, belief, commitment and cooperation among school teachers, parents, student councils and local authorities together with civil societies, private sectors and donor organisations over time were explored in this study.

## Introduction

At the recent 3<sup>rd</sup> Global Ministerial Conference on Road Safety in Stockholm aimed at achieving Global Goals 2030, it was acknowledged that all countries still facing many challenges although lessons learnt gained from the recent Decade of Action for Road Safety 2011-2020 implementation, so that many more proven measures need to be intensified. The World Health Organization (WHO) data showed that Cambodia is among the 10 target countries having a remarkably high percentage of motorcycles<sup>4</sup>.

According to the traffic police data in the region, the causes of road traffic crashes on rural roads were human error (95%), unsafe road condition (2%), and malfunctioning of vehicle (3%)<sup>5</sup>. Over 200 schools located along the rural community road network are characterised by limited traffic management and limited speed reduction measures. There are no 'good practice' warning signs, speed humps, rumble strip sidewalks, crosswalks and zebra markings in front of these schools. The dangers are increased as there are no assigned teams to coordinate the traffic flow while students are moving to/from schools. Additionally, drivers have limited knowledge of speed risks and pay little attention on speeding.

## Methods

The study reviews the changing trends of Cambodia's road traffic crashes covering speed casualties. It assesses the challenges, local community practices and practical countermeasures that fit within

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<sup>1</sup> Source: Road Crash and Victim Information System (RCVIS) 2018

<sup>2</sup> A keynote addressed by the Senior Minister of Transport at the Road Safety Monthly Meeting on 27 February 2020

<sup>3</sup> Cambodian National Road Safety Action Plan 2011-2020

<sup>4</sup> The WHO Global status report on road safety 2013

<sup>5</sup> Commune and district police data sources in 2017

Cambodia's social, cultural and psychological context after the implementation of demonstration safe school zone projects. A fully structured questionnaire was used to interview school principals, teachers, villagers, students and road users around schools, as well as speed observations and vehicle counts. The collected data was evaluated, analysed and interpreted using Microsoft Excel and SPSS, police data source and road crash victim and information system (RCVIS). Further, observational and assessment of the programme interventions in rural community also used in this study.

## Literature Review

From 2006-2015, the road fatality rate per 100,000 population continued to increase from 9.6 up to 14.5 while the population increased by 18% and registered motorised vehicles increased almost 500%, of which about 88% were motorcycles. The fatality rate showed a downward trend to 11.9 per 100,000 population with the revision and implementation of Cambodian road traffic law adopted on 9<sup>th</sup> January 2015.<sup>6</sup> This law was widely disseminated to the general public via public education, campaigns, media and social media under a coordination role of the National Road Safety Committee (NRSC), government ministries and institutions, civil society organisations, and the private sector. As of January 1<sup>st</sup>, 2020, a fivefold increasing of fines on speed violations, disobey traffic signs, drink driving and other infractions were also put into force by traffic police across the country.

Speeding, dangerous overtaking and drink driving have long been the leading cause of road crash fatalities in Cambodia. Primary and secondary data on speed related road traffic crashes were reviewed and analysed; and a recent assessment of knowledge, attitude and practices as well as speed observations in 2018 and 2019 were undertaken in 5 targeted provinces. Findings were also compared to a study on speed monitoring conducted by the Handicap International (HI) in 2010<sup>7</sup>.

## Interviews

The current study and observations showed that speeding has a direct impact on crash rates and severity. According to the interviews conducted with school principals and teachers in the targeted areas, the major concern is speeding around the school area. The interviews indicated that around 90% of primary students come to school by walking or riding a bicycle to and from their school. Notably, 65% of secondary school students and 60% of high school students was observed and recorded<sup>8</sup>. According to interviews with the community leaders around the black spots, the victims of the road crashes are mostly the outsiders, not their community members. However, it is very dangerous for local children if people still drive so fast and carelessly across the community mainly in and around residential and school areas.

It is also a critical challenge for commune police to enforce traffic law along rural roads due to lack of technical knowledge and capacity, officers, material and equipment and authorised duty to conduct enforcement operations on either speeding, non-helmet wearing or drink-driving. Commuters and some local young drivers drive in a high speed after the rural roads have been upgraded and paved. In response to this emerging issue, the commune police officials and local authorities are able to raise awareness to villagers, parents and students about the dangers of speeding, not wearing helmet while riding motorbikes, and drink driving. Since more than half of the children in Cambodia walk and ride bicycles to and from school, teaching them to safely walk and ride bicycles, and encouraging the community people in self-enforcing is a key contribution to the prevention of road crashes along rural roads.

Our mission is to reduce road crash fatalities and severe injuries on all Cambodia's roads, updating knowledge and skill sets from successful countries, using technological support, and regularly

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<sup>6</sup> <https://www.phnompenhpost.com/national/king-signs-new-traffic-law-says-govt>

<sup>7</sup> Handicap International study on speed monitoring in Cambodia in 2015

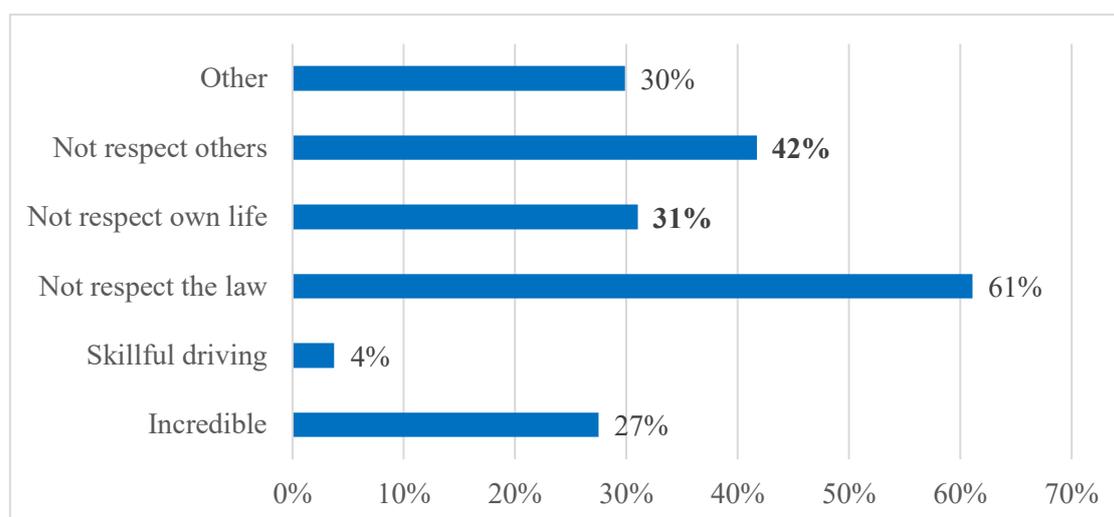
<sup>8</sup> Mode of commute and ratio around school zone in Takeo province in 2017

building capacity for traffic police to enable them to have effective enforcement plans and implementation in their respective locations. We have made efforts to make drivers understand and obey the road traffic law, and to know, if ignored there will be serious losses.<sup>9</sup>

## Finding and Conclusion

This study has identified challenges, experiences and practices around school zone along rural roads that have just completed upgrades to their pavement and road infrastructure. Identified in the traffic count around schools, although less than 100 vehicles are passing school zone in one hour, 76% are speeding by 30kph. Therefore, road safety is a concern for both villagers and students due to speeding. Our surveys found that 55% of local villagers and 42% of students feel unsafe on the paved rural road. It is very clear that safe school zones are believed by both the principals and teachers to be the shield to protect students from road crashes around school. They fully support safe school zone programme implementation at their schools with a combination of education, demonstration, practicing and coaching, engineering and enforcement.

In measuring knowledge, attitude and develop understanding of psychological road users behaviour in the rural community, it was found that 66% of respondents are not aware of the road traffic law set speed limit for vehicles. These speeding drivers are considered as a driver without respect to road traffic law (61%), those who do not respect others (42%) and those who do not respect their own life (31%). Further, of concern is that 83% believed 'in a hurry' is an excuse of commit speeding.



**Figure 1. Road users' attitude toward speeding along rural roads**

Among male motorcycle and car users, 59% admit they used to drive more than 40kph along rural roads. Males are more likely than females to commit speeding. The assessment has also indicated that 77% of respondents also stated that they were in a hurry, while 18% mentioned that the road was clear, so it is the reason for their speeding. 35% of respondents were stopped by traffic police due to not wearing helmet, but not speeding. The programme implementation has encouraged parents and guardians to participate in safe school zones importantly when their children are going to and from school, however their participation is still quite limited. Schools also has lack the knowledge, capacity and resources to promote road safety around respective schools unless programme delivery is with the support of government ministries, civil society organisations, development partners and stakeholders. This support is essential in order to build the capacity of teachers, parents and students, volunteers and local authorities. These organisations assist to form safe school zone groups, and provide equipment and supplies.

<sup>9</sup> Quote of Gen Him Yan, General Commissariat of National Police, Ministry of Interior.

Since more than half of the children in rural community walk and ride bicycle to and from school, teaching them to walk and ride bicycles safely as well as proper use of helmets is seen as an important element that contribute to sustainable community-based road safety. Further, providing road safety education, demonstration, and practicing on the roadside with the involvement of parents, volunteers and local authorities will build confidence for students and their readiness to handle traffic situations, such as choosing a safe time to cross the road, walk or ride their bicycle to and from school safely. Ideally parents are a central figure in their children's safety education. Parents have the best opportunities to effectively assess their individual child's skills and support their safe behaviour in the course of their daily life.

The strengthening of 5Es, namely "Education", "Enforcement", "Engineering", "Encouragement" of parents, student, teacher and local authorities and readiness of "Emergency Response" would ideally create the success and sustainability of safety school zone programme in our rural community. Further, some road engineering low-cost effective measures shall be applied that include the installation of speed reduction signs, rumble strips with applicable distance along straight road, separation footpaths for pedestrian, highly reflective centreline and delineation would be very useful to remind road users while they are driving on the road. At the same time, the increasing and capacity building for local traffic police and support of specialised equipment, and then to develop effective and measurable enforcement plans and interventions especially around schools and residential zones would indeed for drivers towards safety compliance and mitigate the severity of road crashes caused by speeding.

### **Acknowledgements**

This study would not be able to happen without the commitment and support of key road safety ministries, involved civil society organisations and stakeholders who provide data, information and knowledge sharing of their project/programme implementation. The authors wish to express special thanks to those programme teams who supported the data collection through interviews, observations and analysis, and importantly to those specialists who have been involved in various road safety projects in Cambodia and spending times to provide guidance on this paper.

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## The Mitchell Highway Safer Asset Cross-Section Pilot Project

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### Abstract

In New South Wales (NSW) just over one-third of fatal and serious injury lane departure crashes between 2014 and 2018 occurred on state highways despite state highways comprising only 9.2% of all roads in NSW. Through decades of ‘black-spot’ style treatment programs in NSW, many of the specific road deficiencies on state highways have been addressed. Transport for NSW (TfNSW) is now addressing the remaining systemic risks that present over entire routes. Aspirational cross-sections for different road classes with supplementary guidance on selection of safer asset cross-sections have been developed and piloted on a section of The Mitchell Highway.

### Background

State highways comprise only 9.2% of NSW roads but just over one-third of NSW fatal and serious injury lane departure crashes occurred on them between 2014 and 2018. This is equivalent to 2,615 fatalities and serious injuries per year on average?

Austrroads has recently recommended a new evidence-based approach to identifying problem locations which considers road characteristics and applies a whole-of-network approach to predict likely locations of future crashes (Austrroads 2018). This represents a shift away from problem locations having been identified using the reactive black spot approach where specific locations with a high concentration of crashes are defined as high risk (Sørensen & Elvik, 2007).

A series of aspirational cross-sections for various categories of road has been developed by TfNSW, providing a platform for network-wide systemic transformation of the NSW state road network, better aligned with Safe System principles.

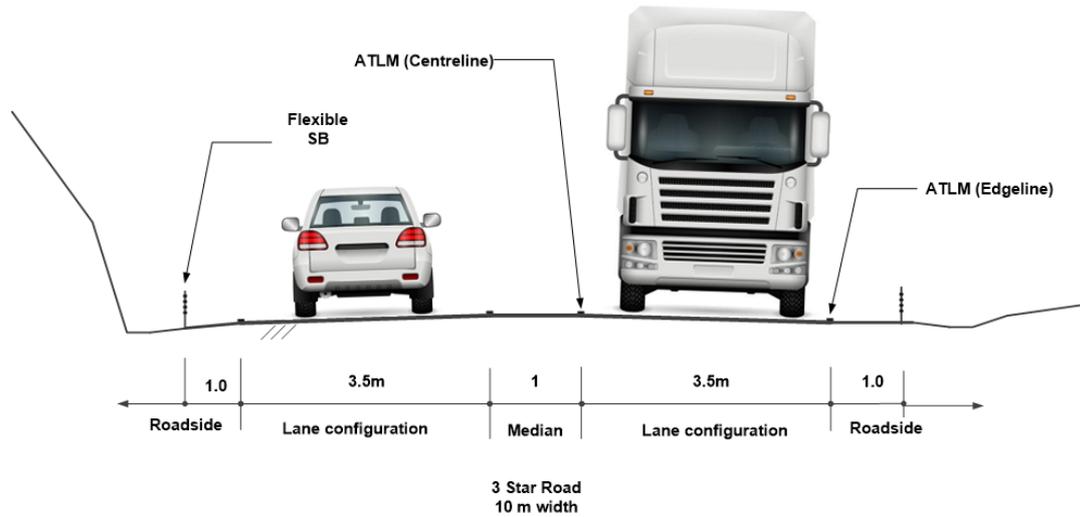
Aspirational cross-sections developed detail formation, lane and shoulder widths, use of roadside and median barriers and Audio Tactile Line Marking (ATLM). They are specific to different annual average daily traffic volumes (AADTs). (see Figures 1 to 3 as examples). To aid practitioners in detailed decision making, TfNSW undertook pre-emptive asset cross-section iRAP Star Ratings for a wide variety of configurations of cross-sections.

### The Mitchell Highway Safer Asset Cross-Section Pilot Project

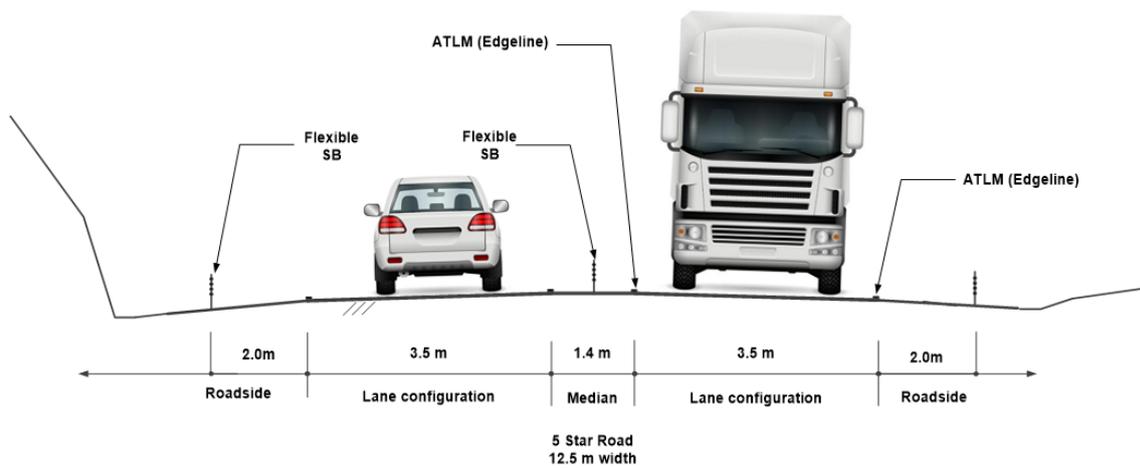
The Mitchell Highway between Bathurst and Orange was selected as a pilot route for implementation of a safer cross-section. It is a 47.5km, mostly 2-lane undivided carriageway with 3.63 kilometres of existing centre median barrier (divided into 7 separate segments). The AADT is 9,500 vehicles/day. It has a concerning / high? crash rate: 116 crashes in the 5 years to 2017 (7 Fatal, 31 Serious Injury). 55 Fifty-five occurred on curves and 27 were attributed to driver fatigue. Run-off road crashes occurred most frequently (n=65) followed by head-on crashes (n=15). 36 of the run-off-road crashes occurred on curves, 29 on straight sections.

### Project development by aspirational cross section gap analysis

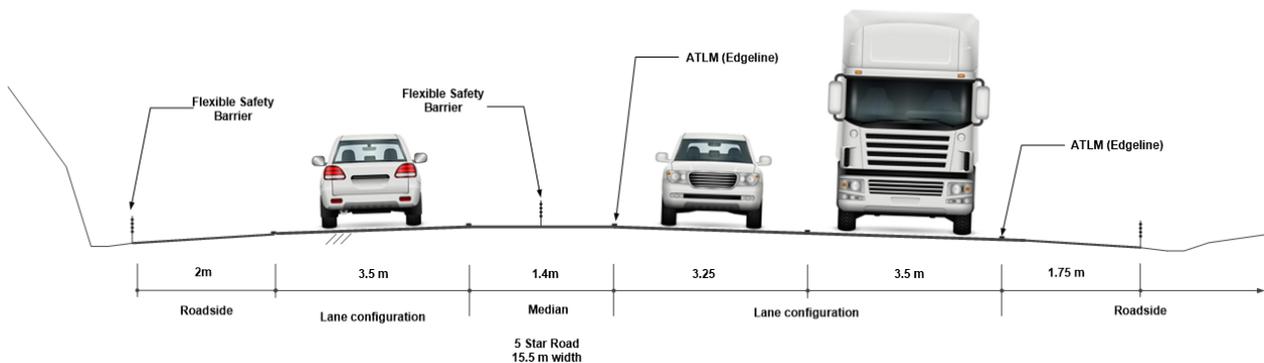
Using the aspirational cross-section for traffic volumes 6000–12000 AADT as a blueprint, a review (gap analysis) of this section of the Mitchell Highway was conducted. \$50 million funding was



**Figure 1 – Aspirational Cross-Section for traffic volumes Annual Average Daily Traffic (AADT) 3000 – 4500**



**Figure 2 – Aspirational Cross-Section for traffic volumes AADT 4500 – 6000**



**Figure 3 – Aspirational Cross-Section for traffic volumes AADT 6000 – 12000**

allocated to begin transforming this section of the highway to meet the aspirational cross section as pilot project. The scope of the project consists of:

- Installation of wire rope barrier on the median (1.4m in width) and flexible roadside (shown to reduce fatal and serious head-on crashes by up to 87% (Candappa et al, 2011).
- Widening of sealed shoulders to at least 1m on straight sections of road (most vehicle recovery occurs in the first 1.0 m of shoulder (Transport for New South Wales, 2019))
- Sealed shoulders to 3m where both centre and roadside barrier exists, to allow for safe maintenance and emergency vehicles access and vehicle breakdowns. (Austroads, 2016)
- Installation of Audio Tactile Line Markers (ATLMs) on edge lines and centrelines (shown to reduce head-on and run-off road crashes by up to 25% (Charlton, 2007)), where possible based on sensitive receivers.
- Installed chevron alignments markers (CAMs) at bends (shown to be effective in guiding vehicle drivers around bends and reducing vehicle travel speed (Jennings et al., 1985; Charlton, 2007; Wu et al., 2013)).
- All rural intersections receiving protected turn lane treatments.

### **Project development by aspirational cross section gap analysis**

. The first 4kms of this upgrade has recently been completed in line with the aspirational cross-sections. As this has been a pilot project, the aspirational cross section has evolved as various sections are delivered within the length, and will potentially continue to evolve as lessons are learnt. The next steps will be to evaluate the effectiveness in reducing road trauma and also the effectiveness of the refined cross section. 2020, marks the first year since 1999 that there had not been a fatal crash along the Mitchell Highway.

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## Development and Delivery of the Pedestrian Protection at Signalised Intersection Mass Action Program

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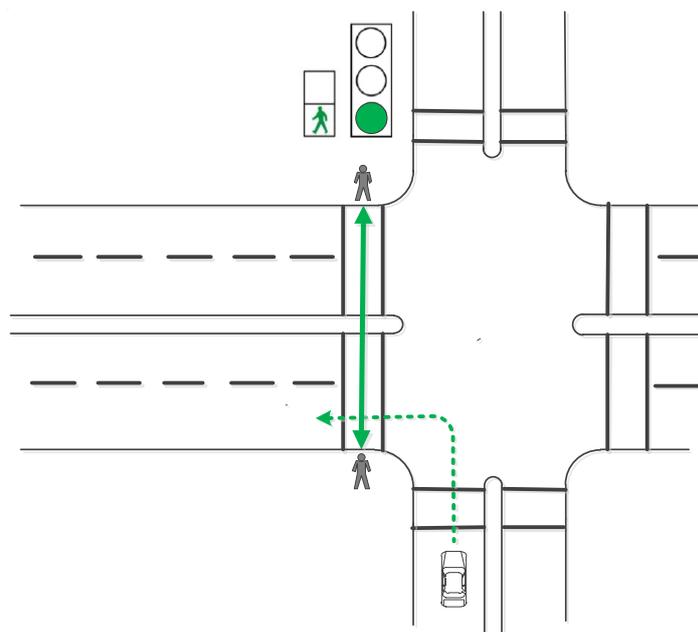
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### Abstract

The New South Wales (NSW) Centre for Road Safety (CRS) conducted a review of pedestrian safety at signalised two-phase intersections, and the impact on safety where parallel green signal for both vehicle and pedestrians traffic signal phasing is used. Specifically, the review looked at the potential introduction of Timed Pedestrian Protection (TPP) at signalised intersections to provide temporal separation of pedestrians and vehicles. The review found that TPPs had reduced the number of pedestrian crashes at intersections. Additionally, a crash reduction factor calculation based on NSW roads estimated that if TPPs were implemented on NSW roads they could reduce pedestrian crashes at signalised intersections by up to 35%. Thus, the literature review and crash reduction factor calculation suggested that replacing parallel green signal for both vehicle and pedestrians traffic signal phasing with TPPs would significantly contribute towards reducing pedestrian crashes at signalised intersection crossings.

### Background

The New South Wales (NSW) Centre for Road Safety (CRS) conducted a review of pedestrian safety at signalised two-phase intersections following a series of pedestrian fatalities at these intersections. The review focused on the two-phase traffic signal operation that uses parallel green signal for both vehicle and pedestrians ('green-on-green'). In this signal operation the circular green signal for a turning driver commences at the same time as a green walk signal on a parallel pedestrian movement (Figure 1). In this type of operation, pedestrian protection is not provided. This review was performed to determine whether there were viable and safer alternatives to this practice.



**Figure 1:** Parallel green signal for both vehicle and pedestrian operation at a signalised intersection

## **Current Practice**

In NSW, guidance on the traffic signal provision and operation is provided in the Traffic Signal Design Guide (TSDG) (Roads and Traffic Authority, 2008). The Guide does not stipulate design requirements but, instead, provides guidance on the design and operation of signalised intersections.

A literature review was performed on Timed Pedestrian Protection (TPP) to determine their suitability for application on NSW roads. TPP is a method of traffic and pedestrian control whereby the red turn arrow or a delayed start are used to hold turning traffic for a period of time while the green pedestrian signal is displayed thus allowing pedestrian parallel movement to occur. This type of treatment is more consistent with the Safe System approach to road safety because it provides a temporal separation between pedestrians and turning traffic.

## **Literature Review Findings and Recommendations**

TPPs result in a reduction of turning drivers violating pedestrians' right-of-way, reduced crashes and fewer pedestrian-driver conflicts (Fayish & Gross, 2010; Hubbard et al., 2008; King, 2000; and Pecheux et al., 2009). A crash reduction factor based on NSW roads estimated that if TPPs were implemented on NSW roads they could reduce pedestrian crashes at signalised intersections by up to 35%.

This literature review and crash reduction factor calculation suggested that replacing parallel green signal for both vehicle and pedestrians traffic signal phasing with TPPs would significantly contribute towards reducing pedestrian crashes at signalised intersection crossings.

## **Mass Action Program to install TPPs across NSW**

From these findings, the NSW Government announced a mass action program to upgrade 560 two-phase signalised intersections with TPPs. This program included infrastructure changes to upgrade existing signals with left-turn red hold arrows or to complete signal phasing changes. As part of this program, 'Left Turn on Red' practice was also reviewed and removed where it conflicted with a TPP upgrade. Of the planned sites, 470 sites had been completed by November 2019. CRS is monitoring crash rates at completed program intersections, assessing rates before and after implementation. Preliminary work is promising, however more time is needed to obtain sufficient data to reliably assess road safety impacts and comparison with control group locations is needed to address key limitations. A more detailed outcome evaluation will commence when sufficient data are available.

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# Identifying cycling stress to inform cycling infrastructure investment

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## Abstract

The Victorian Cycling Strategy (the ‘Strategy’) has a goal of ‘Investing in a safer, lower-stress, better-connected network’. To achieve this, we need to be able to clearly identify locations of greatest risk of danger for cyclists, now and into the future. The Strategy requires that a level-of-traffic stress (LTS) approach is used when investing in the cycle network.

The State Government lacked an evidence-based tool for targeting and prioritising investment in the cycling network. A comprehensive LTS tool has been developed that assesses on road mid-block and intersection conditions, including infrastructure, motor vehicle speeds and volumes. Further development of the tool includes user perception testing to understand LTS from a user’s perspective and use this information to refine the tool.

## Objectives

This project has developed a practical tool to assign and visualise level of traffic stress (LTS) to streets and roads within Victoria. The tool requires project level data inputs and therefore the collection and collation of cycling asset data for the Strategic Cycling Corridor (SCC) network is also included in future stages of the project. Further development of the tool includes user testing to understand LTS from a user experience perspective.

## Introduction

Approximately 60 percent of the population are curious about cycling and like to ride, but they don’t cycle, or cycle less, due to the need to ride close to motor vehicles and pedestrians. Research and consultation for the Strategy showed cyclists’ biggest concern is traffic stress – the potential or actual stress arising from interactions with motor vehicles (other stresses exist but traffic is the most important factor).

Traffic stress (including vehicle volumes, speed and parking activity) is a significant concern and people often avoid high-stress areas (see Figure 1). Protected infrastructure will minimise traffic stress and a level-of-traffic-stress approach can be used to guide investment in cycling infrastructure.



Source: Figure 6, Victorian Cycling Strategy 2018-2028

**Figure 1. Level of traffic stress scale**

Historically, investment in cycling infrastructure (as with most transport safety initiatives) is derived from crash history and demand. While valid, this reactive method invests in locations where people are already cycling. These may not coincide with the highest-stress locations which form barriers to new people riding.

### **Project Summary**

This project has developed a level of traffic stress (LTS) tool that has been tailored to the Victorian context and informed by international best practice. It provides the Government with an evidence-based approach for identifying high stress locations on the state's cycling network.

The excel based tool assesses both mid-block and intersection infrastructure including:

- Cycling infrastructure type
- Influence of mid-block traffic volumes and speeds (where there is no physical separation from traffic)
- Influence of bicycle lanes widths (and adequate separation from parked vehicles where non separated)
- Impact of kerbside activity (e.g. parking or stopping on bicycle lanes)
- Interaction with heavy vehicles
- Interactions with trams (separation and crossing tracks)
- Intersections and crossings types and bicycle infrastructure, including roundabouts

The LTS score of a cycle route or link is equal to the score of the worst performing element. The tool is currently an infrastructure and traffic conditions assessment of LTS. The next stage of developing the tool includes focused user preference testing to better understand the infrastructure preferences of the 'interested but concerned' demographic. These user preferences will be used to further refine the LTS tool and to inform the creation of a cycling infrastructure asset data collection list.

### **Future Opportunities**

It is hoped that the project will create valuable data and resources that can be shared with other Government departments and Universities to provide enhanced forecasting of cycling exposure, risk and infrastructure planning.

*It is noted that at the time of submission of this abstract, only Stage 1 has been completed, however some early outputs from the other stages of the project are expected by the time of the conference.*

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## Raised Intersections at Traffic Signals in Victoria

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### Abstract

Across Victoria, 28% of deaths and 41% of serious injuries occur at intersections. In Metropolitan Melbourne, 38% of serious casualties at intersections occur at traffic signals. To address this issue the Victorian Government invested in a trial project to retrofit raised intersections at traffic signals. Raised intersections are a speed management treatment capable of reducing the operating speeds for vehicles through an intersection to Safe System collision speeds.

In 2019 seven raised intersections were installed at intersections along two routes in the Thomastown area, north of Melbourne. Following installation an evaluation was undertaken which showed the changes in mean speed on the main roads, on approach to has decreased by approximately 10.7km/h. Through the development and delivery process learnings were gathered on several aspects of the treatment such as drainage, delineation, communication strategy and truck stability, and included in the update to the *Road Design Note 3.07 Raised Safety Platforms*.

### Background

There is a limited number of treatments that can be retrofitted to a signalised intersection to improve safety. These treatments can include fully controlling the right turns, installing mast arms or pedestrian head start phases. The main drawback with these treatments is that they are an advisory-level intervention and rely on driver compliance. To have a greater impact on road safety and achieve the aim of zero deaths and serious injuries on the road network, a physical-level intervention that accommodates for human errors is required.

Raised intersections are similar to treatments such as speed humps or safety cushions which have been used for many years on local roads to reduce vehicle speeds. They have not been traditionally used on arterial roads in Victoria, with higher traffic volumes and freight. Raised intersections have been used successfully at signals in other countries, including the Netherlands, for many years.

### Trail Sites

The sites for the trial were identified based on several criteria including speed zone, crash history, freight volumes, public transport routes and geometry. To maximise the early learnings from the initial sites a combination route treatments and isolated sites, divided and undivided roads and three and four leg intersections were sought during the site selection process.

To deliver this innovative program a working group was convened, bringing together expertise in development, design, delivery, signal operations, evaluation, engagement and communications. The working group met regularly to discuss progress, issues and share learnings.

### Learnings

There were several main learnings identified during the design and delivery process. These learnings were used to update DoT's Road Design Note.

### Truck Stability

As truck stability was raised as a risk during the early development stages, truck stability assessments were conducted on four of the seven sites. The results showed that if the ramps are

located prior to when the vehicle turns, they will not contribute to the destabilization of heavy vehicles.

### ***Communications Strategy***

While engagement was undertaken with the local community prior to and during construction, it was evident after construction that more had to be done to inform the through traffic of the treatment. This was done with targeted Facebook posts and variable message signs on the routes information of changed conditions along the main routes.

### **Evaluation Results**

To evaluate the effectiveness of the treatment, before and after speed measurements on the main roads were undertaken on the approach and departure of the intersection. Table 1 shows the results.

***Table 1. Mean Speeds at the Intersections***

<b>Location of observation</b>	<b>Mean speed (km/h)</b>		<b>Difference</b>
	<b>Before</b>	<b>After</b>	
<b>Approach to intersection</b>	43.4	32.6	-10.7 (-24.7%)
<b>Departure from intersection</b>	45.4	40.8	-4.6 (-10.1%)

A further evaluation is being undertaken including: comprehensive analysis of extensive speed measurements and behavioral observations, red-light compliance, vehicle-vehicle and vehicle-pedestrian conflicts, intersection capacity and heavy vehicle stability. This evaluation is expected to be completed by May 2020.

### **Conclusion**

The initial evaluation of these sites shows promising results and, if continued in the comprehensive evaluation, raised intersections could become a much-needed treatment option to improve the safety at signalised intersections.

## Safer Roads Program Staged Development Process

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### Abstract

The Victorian Governments Towards Zero Action Plan, released in 2016, focuses on safe system treatments including continuous barrier projects on the Victoria's Top 20 highest risk roads. The programs lead to the Safer Roads team to revise the development process to allow the large, complex projects to be delivered within the four year Plan.

The previous process relied on project submissions twice a year based on comprehensive guidelines. These guidelines would take time to develop, and never cover all potential projects. This resulted in many projects being revised, wasting time and resources.

The Safer Roads team developed a ten stage process, which takes projects from an initial feasibility stage to project completion. Development under this new process concentrates on a collaborative approach between project developers and funders. It has resulted in more confidence in the projects developed and has been adopted on all Safer Roads programs.

### Background

Victoria has had a Safer Roads program, also known as the Safer Roads Infrastructure Program or Safe System Road Infrastructure Program, since 2003. These programs are a partnership between TAC and the Department of Transport (previously VicRoads).

Traditionally Safer Roads programs in Victoria have followed the standard project submission and funding process outlined below.

- Step 1: Safer Roads team call for submissions twice a year, providing guidelines on what type of the objective of the program is and what treatments are accepted where.
- Step 2: Regional Offices develop projects to a concept design stage for internal review and approval prior to submission to the Safer Roads team.
- Step 3: Safer Roads team review the projects and provide feedback to the Regions.
- Step 4: Projects are revised and resubmitted
- Step 5: Safer Roads present the projects to a Committee to seek project approval.

This process required comprehensive and detailed guidelines to be written prior to projects being sought by regions which could never cover all possible projects. The process resulted in many projects being reworked and revised following comments by the Safer Roads team, or with projects being fully developed that had very little chance of receiving funding.

### A New Way is Needed

The Victorian Government released the Towards Zero Action Plan in 2016. The centerpiece of the Plan was to install continuous barrier on the Top 20 high risk roads. This included nine divided and eleven undivided roads. These roads were the first to receive continuous barrier treatments in Victoria.

Developing so many large, complex projects in a short timeframe required immediate action. As this was a new type of project there were many unknowns in regards to what scope that would be

achievable. It was therefore impractical to write guidelines prior to commencing the development of projects.

### **The New Process**

A new development process was implemented that relied on continually feedback and review between the offices developing the projects and the Safer Roads and TAC team. The process included ten stages which are outlined below.

- Stage 1 – Feasibility: Regions undertake a desktop assessment of the site based on high level guidelines provided by Safer Roads
- Stage 2 – Concept Workshop: Regions present findings and workshop the potential solutions to the Safer Roads team, who provide advice on proceeding to next step.
- Stage 3 - Project Development: Regions develop the project in detail.
- Stage 4 – Detailed Workshop: Regions present the project to Safer Roads and TAC who endorse the project direction.
- Stage 5: Development Finalisation and Regional Approvals: Regions finalise the projects and receive internal approvals
- Stage 6: Safer Roads Project Approval: Projects are taken through the Safer Roads governance process for approval.
- Stage 7: Preconstruction: Regions undertake preconstruction activities.
- Stage 8: Project Announcement: Project is announced by the relevant person.
- Stage 9: Construction: Project is constructed.
- Stage 10: Project completion: Evaluations conducted if required.

### **Conclusion**

The new development process, with its two workshops and collaborative approach, has allowed for greater confidence in the projects developed. While it was originally implemented for the Top 20 roads it is now being implemented for all Safer Roads programs.

## The “unseen passenger”: current vehicle restraint systems are not designed for safety of pregnant women and their fetus

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### Abstract

Pregnant women and their fetus are vulnerable road users who are not well protected in crashes. Current vehicle occupant protection systems (seatbelts, airbags) are not designed for pregnant women or their unborn child. While pregnant women are advised to wear seatbelts at all times, there is a serious risk to themselves and/or the fetus via placental abruption due to the lap-belt passing over the fetus and directly loading the foetal area in a crash, even in moderate crashes. Some insight is provided into this important neglected area of road safety and proposes action to help develop vehicle restraint safety systems for pregnant women and her fetus, the “unseen passenger”.

### Background and outcome objectives

Published data on incidence of placental abruption occurring in crashes in Australia are unclear. In the 2005 USA study by Duma et al [1] states “*Automobile crashes are the largest single cause of death for pregnant females and the leading cause of traumatic fetal injury mortality in the United States (US). Each year, 160 pregnant women are killed in motor-vehicle crashes (MVCs) and an additional 800 to 3200 fetuses are killed when the mother survives in the US. ...The most common cause of fetal death from motor vehicle accidents is placental abruption, which is the premature separation of the placenta from the uterus...*”

Another 2014 Canadian study by Redelmeier et al [2] found that motor vehicle crashes are the leading cause of fetal death related to maternal trauma. The crash rate from 7,679 total events was found to be 6.47 per 1,000 individuals annually compared to the control group of 4.55 per 1,000 individuals, i.e. a relative risk of 1.42 (1.32–1.53, 95% CI). For women aged 30 years or older the relative risk rose to 1.6 (1.43-1.79, 95% CI).

Similarly a 2017 UK study by Acar et al [3] states “*Road traffic accidents are the largest cause of accidental fatality and the leading cause of traumatic injuries for pregnant occupant and her fetus. Understanding the injury mechanisms of pregnant women and their unborn baby is crucial to improving their safety in road traffic accidents. However, investigations into the cause of maternal and fetal injuries and fatalities following traffic accidents are limited. ... placental abruption is the most common cause of fetal loss in motor vehicle accidents and accounts for around 50%–70% of all fetal mortalities.*

Much well-meaning but simplistic advice is directed at pregnant women on otherwise reputable health, vehicle and road safety websites. While these websites appropriately encourage women to wear their seatbelts while pregnant, they are not sufficiently forthright about the risks nor do they provide alternate solutions, or suggest reducing their travel exposure - particularly towards the end of the second and into the third trimester of pregnancy. Nor apparently - some researchers claim - are obstetricians or health professionals sufficiently informed to provide appropriate advice of the risks and the availability of alternate modified restraint systems [Amy Docher ‘Tummy Shield’ [4]]. To illustrate the misinformation given to pregnant women, one State Government Health Department

website [5] current download brochure *Seatbelts and pregnancy* states “***Will wearing a seatbelt harm your baby? Wearing a seatbelt correctly will not harm your baby....***”. [emphasis added]

The published research identifies that current seatbelt designs are suboptimal for pregnant women, and can result in abdominal loading leading to placental abruption, as occurred in a recent collision investigated by the authors, which was of low severity.

An additional complication and possible increased risk factor for pregnant drivers and front seat pregnant passengers in modern vehicles is the loading arising from seatbelt pre-tensioners which tighten the belt in a collision. The authors are not aware of published studies in this regard.

### **Conclusions and Outcomes**

Current vehicle restraint systems provide suboptimal safe systems in crashes for the pregnant woman and her “unseen passenger” - the fetus. From a first principles lens, seatbelts may increase rather than reduce impact forces applied to the fetus. The ideal restraint system for a pregnant woman carrying a baby will serve to ride-down crash energy while avoiding the application of forces in the abdominal area. This must be done while minimising the risk that the restrained pregnant woman will slip out of the belt. The femur is a strong structural element of the skeleton and could provide a load path rather than across the pelvic bone. Validation testing of alternate restraint systems will of course be required.

One measure used to reduce risk is to re-route the lap belt under the foetal position and over the women’s upper legs and thigh. Some such aftermarket products are available but are not widely known or promoted in the community, and it is unknown to what degree crash testing and validation studies have been carried out.

Unfortunately, there is an important gap in the available information regarding the dangers of seatbelt injuries to fetuses. New parents are often more focused on buying the safest baby capsule on the market. Unconsciously, their concern for baby safety in vehicle crashes may be greater after delivery— than before!

There are countless warnings and advice available to pregnant women for reducing risk of trauma to the fetus or baby. Women are cautioned against eating soft cheese, warned to limit coffee intake and told to take iron. All of these measures are done to mitigate risk. It is important to evaluate the relative risk posed by seatbelts in vehicles, and by crashes in general, particularly in the last trimester. The first step is awareness of the problem and this requires evidence-based research.

The objective of this presentation to highlight the need for a fresh approach to this neglected area of crash safety for pregnant women and protecting their fetus, and to prompt road safety and health authorities and the auto industry on the need for better collection of such crash and injury data, and to fund research projects to help develop safety systems for pregnant women.

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## Demonstrating enhanced Safety Model Corridors in Iran

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### Abstract

In Iran, road traffic crashes are one of the five leading causes of fatalities. Unfortunately, in 2017, the downward trend in road fatalities had changed, after nearly a decade of decreases in fatalities. To reverse this trend, a project has been designed to demonstrate enhanced Safety Model Corridors based on the Safe System Approach (SSA) and Result-Based Management Approach (RBMA). The focus of this project is road safety engineering and speed limit reductions, strengthening surveillance, monitoring and evaluation, improved crash investigation, improved governance, enhanced law enforcement, social marketing, and quality improvement of post-crash care services. The scope and challenges of the project, planned actions and early achievements are discussed in this paper.

### Background

A review of road safety in Iran was conducted by the World Health Organisation (WHO) country office and its national counterparts in 2018. Speed management and the governance of the road safety system were highlighted as priority areas to enhance road safety. Therefore, a pre- and post-studies have been designed to demonstrate enhanced safety model corridors. These have been based on the Safe System Approach (SSA) and Result-Based Management Approach (RBMA) on selected road corridor lengths in Isfahan, Khorasan and Markazi Provinces of Iran.

### Methods and aims of the Project

An independent review by international and national experts of the speed management problem in Iran. The recommendations of this review were used to develop a pilot project to introduce better practices and more collaborative ways of addressing the problem.

This project, currently underway, aims to facilitate the implementation of the SSA and RBMA in the national road safety system through presenting an effective and practical good practice model. The project has been recognised as a regional demonstration project with the best practices of the project to be shared with WHO Eastern Mediterranean Region countries.

### *Six main components of the project include:*

*Two cross-cutting components:*

- 1) Comprehensive Governance and Management through establishment of a comprehensive multisectoral mechanism at national and provincial levels for road safety and capacity building of service providers;
- 2) Surveillance, monitoring and evaluation through designing and implementing the project based on RBMA as well as improved crash investigation practices;

*Four Intervention components:*

- 3) Road engineering through setting speed limit in rural roads following an integrated SSA and Movement and Place Framework (MPF) approach and designing and implementing speed calming/risk reduction interventions in the selected corridors;
- 4) Legislation upgrade, and enhanced enforcement through training and procedures including offence processing from detection to final resolution;
- 5) Social marketing and public education with a focus on enhancement of compliance of road users' behaviour with safe speed; and
- 6) Post-crash emergency response and care improvement through continuous quality of service based on results of quality assurance and accreditation mechanisms;

**The project is designed in two phases:**

- a) **Preliminary Phase** that aims to establish an effective governance mechanism, development of detailed action plan, development of Surveillance, Monitoring and Evaluation Framework (SMEF), capacity building of human resources and baseline survey.
- b) **Implementation Phase** that aims to conduct planned interventions and regular monitoring and evaluation based on the new SMEF and development of investment case for scaling up of the best practices.

Currently, the implementation phase is underway. Baseline data has been collected. Cross-agency project pillar groups have been established and are working on elements of the project plan. In addition, project team members have been provided with training by international road safety experts. Meetings have been held at provincial level to secure understandings and commitments by local project teams.

The WHO Eastern Mediterranean Region has agreed to use the results of this demonstration project to guide speed management practices across the Region.

**Project Achievements as at October, 2020**

Thusfar, project achievements include:

- A road safety partnership was formed to facilitate implementation<sup>1</sup>;
- A coordinating mechanism was established at national and provincial levels with provincial governors and other senior government leaders in charge;
- Scientific evidence that speed management is a crucial road safety measure has been shared with those who once doubted this;
- Accountability through reporting mechanisms to the National Road Safety Commission has been established and resources have been made available to the project by national partners;

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<sup>1</sup> The partnership includes representatives from: RMTO (Road Maintenance & Transport Safety Organisation, Road Traffic Police, Ministry of Interior (Transportation and Traffic Department), Ministry of Health and the WHO Country Office.

- A draft road safety engineering protocol has been prepared including three main parts: segmentation, speed limits, and traffic calming;
- Segmentation of selected corridors is completed;
- Speed limit, traffic calming and risk reduction interventions have been defined;
- A speed enforcement situation analysis has been conducted and suitable actions have been proposed;
- A social marketing package, based on formative research has been developed;
- The National Road Safety Commission has approved regular reporting of severe injury cases as an impact indicator of the road safety system;
- A draft injury severity concept has been developed;
- A draft post-crash care accreditation protocol has been developed; and
- A mandatory crash investigation protocol has been developed for all crashes with severe and fatal injuries has been endorsed by the National Road Safety Commission.

**Early operational lessons:**

- Having effective partnership with key stakeholders in whole cycle of a road safety initiative, from planning, implementation and evaluation is necessary. This requires effort, common aims and good will between all stakeholders.
- Community advocacy is needed to encourage interagency cooperation and engendering political will to do what is required.
- Results-Based Management Approach (RBMA) can enhance accountability of stakeholders. Defined Surveillance, Monitoring and Evaluation Framework (SMEF) is vital in RBMA.
- Securing support of policy makers and to end technical debate on results of a pilot study, having data quality auditing and external evaluation is crucial.
- Development of case studies and investment cases to enhance road safety in developing countries is highly recommended.

# **An omnichannel approach: Queensland's Road Safety Education Blueprint for Children and Youth**

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## **Abstract**

Road trauma is a leading cause of death of Queensland children (QFCC, 2019). A whole-of-life approach to road safety education is required to shape and influence behavior which will drive a generational shift in the awareness of being a safer road user. The Queensland Department of Transport and Main Roads (TMR) recognizes the key role they play in road safety education and created a new Road Safety Education Blueprint for Queensland Children and Youth (the Blueprint). This Blueprint was developed through a review of literature, other jurisdictional initiatives, and in consultation with stakeholders across Queensland. This process identified pragmatic outcomes by analysing children's risk profiles and the current road safety education landscape including service providers, effective pedagogies and gaps across ages, content and geography. The result is a Blueprint articulating a vision for a continuum of evidence-based education across childhood through an omnichannel approach, supporting and enabling a behavioral shift of the current and emerging generation of safer road users.

## **Background**

As the lead agency for road safety in Queensland, TMR has a responsibility for road safety education. Driving a fundamental change in culture and attitudes towards road safety is one of four principles that underpin the *Queensland Road Safety Strategy 2015-21* and the efforts to reduce serious road trauma (TMR, 2015).

The *Queensland Road Safety Action Plan 2020-21* recognises that whole of life education is critical to achieving a vision of zero road deaths and serious injuries. To deliver a holistic approach for children's road safety education, TMR has developed an evidence-based road safety education Blueprint to better guide future initiatives for children and youth (TMR, 2019).

## **Blueprint Development**

The Blueprint was developed across multiple stages that involved reviewing literature, data analysis, national and international jurisdictional scans, age risk profiling, stakeholder engagement and the design of actionable initiatives. A review of existing programs was conducted to determine a baseline of road safety education in Queensland. This review enabled the project team to establish a clear understanding of programs, delivery organisations, and the existing gaps based upon children's age, content and location.

This initial understanding was further enhanced through consultation with stakeholders across Queensland. This engagement was conducted through a mixture of workshops, one-on-one interviews and surveys with stakeholders representing other government agencies, clubs, non-government organisations and community road safety educators. As well as providing a comprehensive baseline of programs, this consultation was critical in identifying the challenges and opportunities in providing road safety education to children and youth that are either at risk or that aren't participating in the education system.

The baseline program data was combined with a literature review and road crash data to provide risk profiles for different cohorts from birth, young and adulthood. The combination of these factors enabled the development of strategic pillars that segment areas of focus within the Blueprint. Based upon an understanding of principles that would guide the Blueprint, the strategic pillars and omnichannel actions were validated and prioritised in consultation with an advisory group that represented government and non-government organisations with a role in road safety education.

The final Blueprint and the omnichannel actions are intended to improve the reach of road safety education through a greater use of integrated and contemporary delivery mechanisms that move beyond imparting knowledge and skills and embed behaviours that support a generational shift for safer road users.

### **Next Steps**

The Blueprint and omnichannel actions are the result of an accumulation of best practice literature, community expectation, delivery experience, data and knowledge in road safety education for children and youth. The Blueprint also identifies that there are numerous stakeholders delivering road safety education and provides a path to improved coordination and efficacy of resources.

The TMR project team has now transitioned to the task of implementation of the priority initiatives. The achievement of these initiatives will require TMR to adopt a greater leadership and coordination role by working closely with stakeholders that each play a differing but key role in educating children and youth on being safer road users.

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## Speed Management in Iran

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### Abstract

The level of road trauma is high in the Eastern Mediterranean Region with the Islamic Republic of Iran having a particularly high rate. The Government, assisted by the World Health Organisation (WHO), has recently committed to carrying out some demonstration projects in three provinces that, if successful will form the basis of road safety actions advanced by the WHO across the Region. In recognition that speed is a pivotal factor in achieving a safe road and traffic system, a review of speed management in Iran was carried out in 2019 by a team of international experts in the field. The findings of this review and their implications for future actions are discussed in this paper.

### Background

In response to high levels of road trauma, the WHO country office in coordination with National Road Safety Commission, Road Maintenance & Transportation Organization, Traffic police, National Emergency Organization in Iran conducted a consultancy project on “Technical support towards enhancement of Speed Management strategy for road traffic injury prevention.” They appointed international experts in joint collaboration with national partners to conduct an extensive review of speed management practices in Iran. Also, national counterparts conducted a speed management situational analysis in consultation with the international team.

### Purpose of the Project

The purpose of the project was to investigate the ways that the country was seeking to address the problem of speed related road trauma and advise on how these practices could be improved.

### Description of the Project

The situation analysis was done by the national counterparts in consultation with the International team. The comprehensive report on the situational analysis was written in Farsi with an English summary.

The scope of the project was:

- Establishing protocols, policies, training and education framework for developing road user discipline to modify high risk driving behaviours;
- Establishing a framework for highly visible and active police enforcement strategies;
- Recommending a speed limit policy for different road types/settings in the country; based on situation analysis results and Safe System requirements;
- Preparing a speed management framework with practical steps to apply the recommended speed limit policy within the country;
- Running a series of technical workshops with participation of all stakeholder representatives;
- Finalizing the recommended policy and framework based on the workshop findings;
- Meeting with high-level authorities to advocate for speed management and presenting a summary of findings and recommendations; and

- Recommending applied speed management and traffic calming approaches and strategy (including the criteria to choose the best method of speed management based on the context).

### **Lessons Learned**

Observations of the road environment, road behaviours, and current policies and governance are summarized below.

#### ***Road observations***

In summary

- There were higher posted speed limits than good practice;
- Insufficient signage, lack of credibility and lack of advisory signs;
- Good audio tactile line marking but most line markings were faded or too light;
- Broken and insufficient barrier systems, no good practice wire rope fence;
- Lack of transitional speeds & speed limit zones too short;
- Lack of good practice in traffic calming treatments (mostly humps);
- Unsafe pedestrian crossings and practices;
- Unsafe U-turn and T-intersection designs; and
- Good camera network and VMS/VSL technology.

#### ***Road user behaviour observations***

In summary:

- Noncompliance with speed limits prevalent;
- Dangerous, aggressive/discourteous driving;
- Tailgating, lack of lane discipline, poor use of indicators;
- Speed differentials – trucks vs cars and cars vs cars;
- Counter-flow motorcycle practices & helmet non-compliance; and
- Dangerous pedestrian crossing behaviour.

#### ***Policy and governance observations***

In summary:

- No defined strategy for speed management;
- Strategic enforcement practices need to be enhanced;
- Lack of integrity and effectiveness in the penalty system;
- Lack of interagency collaboration and strong lead agency;
- Disconnect with local municipalities on road & traffic planning;
- Dangerous and ineffective (active) speed enforcement practices; and
- Inadequate driver training and licensing.

### **Implications and Next Steps**

The consultants recommended sixteen specific practical improvements for Iran and advocated three priority actions to start with:

1. Use the new speed limit guidelines to trial changes in pilot sites – enhanced safety model corridor(s);
2. Improve data quality and accessibility; and
3. Plan and carry out public education and general deterrence programs of action.

All recommendations were endorsed by the National Road Safety Commission and a demonstration project in three Provinces has commenced.

## Reviewing Queensland's Indigenous Driver Licensing Program

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### Abstract

The overrepresentation of Indigenous Australians in road crash data highlights the need for the Department of Transport and Main Roads (TMR) to review and redevelop the Indigenous Driver Licensing Program (IDL). Over the past 12 years, the IDLP has achieved excellent results providing licence access to Indigenous communities, however the focus on road safety education under this program tends to be more adhoc. By engaging and interviewing 30 key stakeholders in Indigenous communities throughout Queensland, this research and engagement activity sought to ensure initiatives implemented by TMR (and potentially other Queensland Government agencies) were effectively targeted to achieve positive road safety outcomes for Indigenous communities. Given a driver licence is a ticket to mobility and gaining a broader experience of the world, a key outcome of the work is to provide road safety education by leveraging the reach of the IDLP in key communities earlier in the licensing journey.

### Background

Indigenous Australians continue to be overrepresented in road crash data. Road-related fatalities are 2.7 times higher for Indigenous people when compared with non-Indigenous Australians and road-related crashes are the second highest cause of fatalities for this group (AIHW, 2019). Serious injuries are also of concern with transport-related injuries representing the fourth cause of serious injuries (AIHW, 2019). There is a clear link between transport disadvantage and poorer employment, education and health outcomes (AIHW, 2019).

Research details the positive outcomes associated where Indigenous communities have access to obtaining driver licences, such as a higher likelihood of positive employment and educational outcomes (Cullen et al, 2016). However, there continues to be significant challenges faced by Aboriginal and Torres Strait Islander people accessing driver licences. The IDLP was established in 2006 with a view to facilitate access to driver licences and help Indigenous communities overcome some known barriers.

By engaging directly with Indigenous communities, the review of the IDLP seeks to identify gaps in the current program to ensure initiatives implemented by TMR (and potentially other Queensland Government agencies) effectively target key issues and challenges faced by Indigenous communities in road safety and licensing. The overall aim is to guide a holistic approach to support opportunities for people to access high quality road safety education and licensing that will help them and their communities to stay safe and healthy and improve their economic participation.

### Method

A three-stage approach was adopted to examine the gaps in the current program and identify opportunities for program improvement. The first stage examined the key research literature and identified barriers and enablers for Indigenous people obtaining and maintaining driver licences. The second stage examined the factors identified in the literature review through 30 in-depth interviews with key members across the Western Cape, Northern Peninsular Area, Gulf Region, Townsville and South East Queensland communities, as well as staff working in TMR's Indigenous Driver Licensing

Unit (IDLU). In addition to understanding the provision of driver licences through the program, the interviews sought to understand safe road behaviour and access to road safety education within Indigenous communities.

## Results

The findings indicate the IDLP has supported an increase from 200 licences issued in 2006 to 2,500 licences issued in 2018 demonstrating the significant reach of the program for licence access. However, road safety is viewed as an intangible topic and participants were unsure of how to apply safe road behaviours within their daily activities, and/or lacked a conscious connection to the 'personal importance' of road safety. The gap in the current program highlights a need and opportunity to strengthen road safety education and outcomes in Indigenous communities using a more holistic approach to achieve positive social outcomes. This objective can be achieved by leveraging TMR's current Indigenous licensing program. Participants expressed the value of this education within the community, particularly expressing a need for this education to occur early in schools, as well as in community and adult learning settings.

## Conclusions

Examining the approach to engage with Indigenous communities through their licensing journey represents a significant opportunity to achieve positive social and road safety outcomes. Using a community engagement approach to understand the integration of the current program within communities has identified a number of opportunities for improvement of the current program, particularly associated with opportunities for enhancing road safety education.

## Implications and Next Steps

The results from this research provide the basis for the testing and implementation of several road safety initiatives within Indigenous communities – importantly, these utilise the knowledge and influence of community members to create and sustain 'on country' connection with safe and compliant road user behaviours. These test cases will form the basis of the further review of the IDLP. The goal of these solutions is to provide culturally connected, meaningful road safety education and other social benefits to Indigenous communities throughout Queensland.

## Acknowledgements

Transport and Main Roads acknowledges the significant contribution of Indigenous Professional Services (IPS) to this project.

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## Motorcyclist personas: it's not one size fits all

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### Abstract

There is support in the motorcycling community for road authorities to reconsider their approach to managing the safety of motorcyclists that accounts for the breadth of the market, as well as the differences in motivations for riding. Using a customer-centric approach, the Department of Transport and Main Roads (TMR) undertook research to understand the segments of the motorcycling community and identify different ways to engage with the community using a tailored approach.

### Background

Motorcycle riders are overrepresented in crash statistics (Department of Transport and Main Roads, Queensland, 2020). Motorcyclist involvement in crashes results in significant health, social and economic costs (Risbey, Cregan & De Silva, 2010). The *Queensland Road Safety Action Plan 2020-2021* calls for more targeted engagement with motorcycle riders in order to combat this issue.

Using a customer-centric approach, TMR has sought to understand the different motorcyclist segments and their motivations for riding in order to develop alternative ways to engage with the community. This approach builds on the work already being undertaken with motorcyclists in Queensland and provides an opportunity to further tailor road safety initiatives and solutions to this vulnerable road user group.

### Method

A two-stage approach was adopted to segment the motorcycling community. The first stage engaged 76 participants spread across four in-depth interviews with key motorcycling safety advocates, two in-depth interviews with manufacturers, four focus groups with key stakeholders in the motorcycling community (advocacy groups, associations, retailers, riding schools), as well as seven focus groups with motorcyclists themselves. Each group or participant was asked about motivations for riding, challenges while riding, motorcyclist responsibilities, interaction with other road users, perceptions on different groups within the motorcycling community, communication opportunities and areas for improvement. Responses were then grouped into themes and these were used to develop each segment profile.

The second stage of the research was a respondent validation phase whereby the developed segmentation profiles were tested qualitatively with 28 motorcycle riders and 14 stakeholders using an online community. The participants completed activities over three days that focused on acceptance and refinement of the personas and identification of any gaps.

### Results

This research observed seven groups within the motorcycling community. These groups include: (1) commuters, (2) ride for work, (3) social riders, (4) thrill and risk seekers, (5) adventure riders, (6) avid enthusiast riders, and (7) solo me-time riders.

The respondent validation phase supported the seven personas and the key differences in motivations for riding between each group. It was found that riders may transition between personas

dependent on function and personal motivations for riding. As such, there is a need to develop initiatives that relate to each sub-group rather than adopting a one-size fits all approach. The results also highlight potential areas for road safety initiatives which vary across the groups identified.

## Conclusions

Profiling rider characteristics using a customer-centric approach is a unique approach to focus road safety initiatives toward a road user group rather than relying on a one-size fits all approach to design initiatives. The results of this work provide a new method to engage in a more targeted way with motorcycling communities that considers the different motivations between riders, their varying knowledge and roadcraft skill gaps.

## Implications and Next Steps

The results of this research allow TMR to effectively engage, collaboratively design and develop initiatives to contribute to road safety outcomes. The suggested approaches for the seven personas will inform TMR's engagement with Queensland motorcyclists to gather insights and ideas to keep riders safe on our roads. The goal of taking this customer-centric approach is to develop and prioritise initiatives, for the different rider personas, that will provide outcomes to reduce serious road trauma among this vulnerable user group.

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Transport and Main Roads acknowledges the significant contribution of Enhance Research to this project.

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## Audio Tactile Line-Marking - Mass Action Development and Delivery

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### Abstract

Victoria's audio tactile line-marking (ATLM) program has provided a systematic approach to the reduction of run off and head-on crashes on high risk roads. Tools and strategies were identified and utilised to ensure that benefits are realised earlier. By using rich datasets, simplifying the specification and promptly applying lessons learnt, the program was more cost effective, quicker and simpler to deliver while still treating 65% of the undivided arterial road network.

### Background

The Victorian Government is investing \$70 million into the mass action treatment of high-speed rural roads with ATLM. The program represents a systemic approach to reducing the risk of run off and head-on crashes on Victoria's high collective risk road network. It is expected that 13,000km of undivided roads will be treated, equivalent to 65% of the Victoria's declared undivided road network.



*Figure 1. Black Audio Tactile Line-Marking*

With such a large network to cover, rapid development and delivery strategies were taken to enable the crash reduction benefits of audio tactile to be realised sooner and earlier in the program.

### Mass Action Development

To accelerate the development of the program, key tools were identified and utilised to provide rapid assessment of eligible roads and understand the Fatal and Serious Injury (FSI) saving benefits across the network.

### ***Australian National Risk Assessment Model***

Typically, benefits realisation from FSI savings are calculated based on crash history. However, given the proactive nature of this mass action treatment, the Australian National Risk Assessment Model (ANRAM) dataset was used to model the predicted FSI savings from installing ATLM. ANRAM provides the ability to apply consistent and systematic risk assessment across the network. By applying a ‘what-if’ scenario of installing ATLM, the predicted FSI savings can be rapidly identified by comparing against the baseline collective risk. This allows for faster and more reliable calculation of benefits realisations by understanding risk, rather than crash history, across Victoria’s rural road network.

### ***Road Design Note***

Based on early trials and feedback, a technical specification document was created to align all known requirements and knowledge on the development and delivery of the ATLM program. This technical document, known within the Department of Transport (Victoria) as a Road Design Note, provided a consistent approach to the assessment of eligible roads for ATLM across the network.

ANRAM also provided a rich dataset from which roads can be assessed against the criteria in the Road Design Note. This provided an initial list of eligible roads, which were verified with desktop studies and on-site inspections. This allowed for the development of an ATLM program covering 3,600km of the network to be completed in under two months.

### **Mass Action Delivery**

A simple specification for ATLM was chosen to accelerate the ability for contractors to deliver the works. A single tactile colour (black) and three different configurations (one for centre line and two for edge line) was chosen. This reduced the complexity for the contractors, allowing for continuous installation of ATLM across great lengths at reduced cost.

This strategy has allowed the program to accelerate and deliver on average 2,000km of ATLM per year. This has translated to benefits realised earlier of approximately 10 FSI savings per year.

In addition, the delivery has been staggered across the state, so that early lessons learnt can then be applied immediately to the next contract and reflected into the Road Design Note.

### **Conclusion**

The accelerating tools and strategies developed for this program has allowed for benefits to be realised earlier. This has translated to an average installation of 2,000km of ATLM delivered each year, bringing forward approximately 10 FSI savings. By utilising the existing rich ANRAM dataset, simplifying the Road Design Note specification and promptly applying lesson learnt, the program was more cost effective, quicker and simpler to deliver while still treating 65% of the undivided road network.

## **Twelve Years of Roadside Drug Testing in Queensland: The Extent and Nature of Recidivism**

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### **Abstract**

Driving with any trace of illicit drugs in one's system is against the law in all Australian jurisdictions yet thousands of offenders are detected every year through police-lead Roadside Drug Testing (RDT) operations. The results of RDT offer important insight into the nature of drug driving, however, there has been limited research evaluating the extent of drug driving recidivism. To explore this, a dataset of 67,727 drug driving offences from the Queensland Police from December 2007 to June 2020 was analysed. The results identified 50,442 unique offenders, with 25% of these offenders being detected more than once. For one-time offenders, cannabis was the most common detection. Methamphetamine was the most common drug analysis result detected across all offences, and for recidivist offenders. The results illuminate the need to explore the utility of countermeasures which focus on maximising the deterrent effect of RDT operations, and reducing offending of those already detected.

### **Background**

With evidence emerging that drug-related traffic fatalities have increased in several states in Australia (New South Wales Government, 2017; Davey, Armstrong, Freeman & Parkes, 2020; Road Safety Commission, 2011; Road Safety Commission, 2015), it is becoming increasingly important to understand the factors that are associated with offending. Roadside Drug Testing (RDT) is the primary method utilised in Australia to detect and deter drug driving offenders. Unlike Random Breath Testing, and due to the costs associated with drug testing, police often target drivers for drug tests (e.g. drivers who are visibly impaired or are known to police) (Davey, Armstrong, Freeman & Sheldrake, 2017). In Queensland, RDT has been in operation for over 12 years, with police screening for the presence of Delta-9-tetrahydrocannabinol (THC), 3,4-Methylenedioxymethylamphetamine (MDMA) and methamphetamine (MA). Evaluations of RDT have been conducted previously (Davey, Armstrong, & Martin, 2014; Rowden, Mazurski, Withaneachi, & Stevens, 2011), however, these studies were conducted over 6 years ago and questions remain regarding the extent and nature of drug driving recidivism. Therefore, the aim of this study was to analyse the results of RDT in Queensland since its introduction in December 2007, and identify the factors associated with recidivism.

### **Method**

The study reports on 67,727 drug driving offences detected between December 1<sup>st</sup> 2007 and June 30<sup>th</sup> 2020 as part of Queensland's Roadside Drug Testing program. The dataset was obtained from the Queensland Police Service and included a range of variables, including: a unique identifier number for each unique offender, date of offence, age at offence, gender of offender and the drug analysis result. The dataset had originally held 68,548 offences, with 821 offences removed due to being a duplicate, a false positive or the sample being invalid.

## Results

There were 50,442 unique offenders identified. Of all offenders, 25% had been detected on two or more occasions. The number of reoffences ranged from two to seven, and one offender had 11 offences. Overall, the most common analysis type across all offences was MA (39.3%), followed by THC (34.1%), and then the combination of MA and THC (22.2%). MDMA was more commonly detected with THC (1.65% of all offences) than on its own (0.86%). The table below reports on descriptive statistics for each offence number, and the most common drug type identified at first offence, for offences ranging from one to seven (data for the offender with 11 offences was not included in the table due to ethical considerations). A final analysis was conducted to evaluate the time between offences which identified two key findings: (1) there was approximately one year between the first and second detections for all reoffenders and (2) for those with 3 offences or more, the days between apprehension dimension as detection increased.

## Conclusions

The results provide support for the value of RDT in detecting drug driving events (and supports further expansion of the enforcement approach). However, the extent of recidivism identified in the current study (which in-part is driven by police targeting of known offenders via automatic number plate recognition technology), suggests that the specific deterrent effect of sanction application may be limited for some cohorts. Additionally, the general deterrent effect of RDT may be substantially diluted (compared to RBT) by the increased costs (both in time and money) associated with roadside saliva testing (National Drug Driving Working Group, 2018). Thus, it is crucial to further explore the utility of countermeasures which focus on maximising both the specific and general deterrent effect of RDT operations in order to reduce the burden associated with such offending.

**Table 1. Characteristics of Offence, by Number of Offences**

Offence Number	1	2	3	4	5	6	7
<b>N overall</b>	37552	8774	2621	802	225	49	18
<i>% of reoffenders</i>	-	70%	21%	6.4%	1.8%	0.4%	0.2%
<b>Gender</b>							
Male (N)	29633	6783	2008	616	168	38	10
<i>% of offence N</i>	79%	77%	77%	77%	75%	78%	56%
Female (N)	7919	1991	613	186	57	11	8
<i>% of offence N</i>	21%	23%	23%	23%	25%	22%	44%
<b>Most common drug type at first offence</b>							
<i>N</i>	15969	3768	1283	401	114	24	10
<i>%</i>	42.5%	42.9%	49%	50%	50.7%	49%	55.6%

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# Comprehensive Safety Assessments and Rapid Evaluations Using Video Analytics and Conflict Data: Innovative Approaches from North America

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## Abstract

Towards Zero is focused on eliminating fatal and serious injury (fsi) collisions on the transportation network. Despite recent publications exploring innovative intersection design concepts following Safe System principles, there remains the need to effectively evaluate safety treatments prior to large-scale application. Video analytics and conflict data has been effectively used in North America and Europe to complete comprehensive risk assessments prior to capital investment and for rapid subsequent safety performance evaluations. In many cases this application of technology has identified latent high-risk factors previously unknown from collision data, and follow-up evaluations of safety implementations have resulted in 80-100% reductions in critical- and high-risk conflict events that are most likely to result in fsi collisions. Widespread implementation of video analytics technology with risk severity thresholds based on human impact tolerance will enable a quantitative understanding of safety measure performance, accelerate adoption of safer intersection designs and provide justification for safety investments.

## Background and Purpose

The Towards Zero directive is focused on eliminating fatal and serious injury (fsi) collisions on the transportation network. Central to achieving this goal is a Safe System approach and an understanding of kinetic energy principles. Recent publications have explored intersection design concepts that reduce speeds, impact angles and exposure (Jurewicz et al., 2017); however, there remains the need to effectively evaluate innovative safety treatments prior to large-scale application. To address this deficiency, conflict data from video analytics has been used across North America and Europe. Video analytics technology enables:

- (1) comprehensive safety assessments at intersections prior to capital investments, and
- (2) rapid evaluation of safety treatment performance afterwards.

This innovative approach to understanding roadway risk is essential for identifying which safety improvements are best suited for a particular intersection and subsequently applying countermeasures before additional fsi collisions occur. It is especially valuable for treatments directed at protecting the safety of pedestrians, cyclists and e-scooters; road users who are the most vulnerable in the event of a collision and are often underreported in collision databases. International case study examples illustrate the value of this data and the need for Australasian jurisdictions to leverage proactive evaluation methods.

## Description

Video conflict technologies automatically detect and track road users in video using artificial intelligence and then extract critical safety information such as the direction, speed and temporal separation between road users. Interacting road user trajectories are then classified according to their severity. While some conflict detection technology primarily considers temporal separation of road users, the approach introduced herein considers kinetic energy principles to identify events that are most likely to cause a severe injury or fatality. This approach has resulted in strong relationships

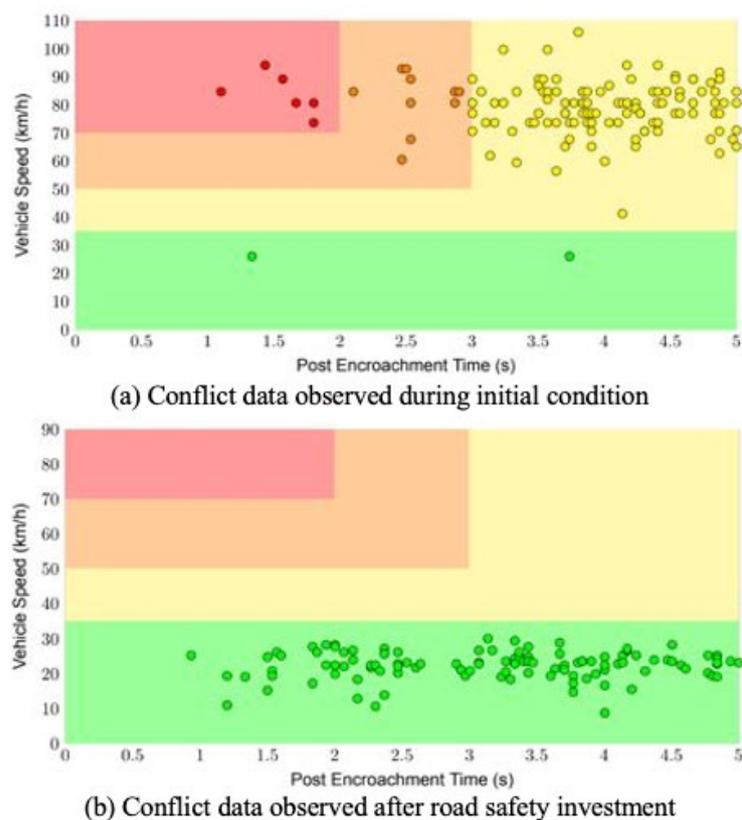
between conflicts and fsi crashes (adjusted  $R^2$  of 94%) (Anarkooli et al., 2021), and has been deployed in 65 communities for diagnostics, safety improvement planning and evaluations.

By developing a standard method of conducting safety reviews and establishing an evaluation framework, Australasian agencies can leverage conflict data to reduce critical road safety risks at intersections.

## Evaluation

Conflict-based safety methods have been successfully used in rural and urban environments, including cities such as Los Angeles, Austin, Vancouver and Amsterdam. Following comprehensive risk diagnostics, latent risk factors were exposed, and precision countermeasures applied to (1) separate road users in time and space, for example through signalization changes and physical treatments, (2) improve the visibility of movements with pavement markings, signalization improvements or signage, and (3) reduce the severity of possible interactions by limiting speeds and lowering impact angles.

Follow-up evaluations of safety implementations installed to target the observed conflict risks have resulted in 80-100% reductions in conflict events that are most likely to result in fsi collisions, as shown in Figure 1.



**Figure 1. Elimination of critical, high and medium risk conflict events following implementation of a roundabout at an intersection in North America.**

## Conclusion

Widespread implementation of video analytics with severity thresholds based on human impact tolerance will result in more proactive risk identification. Evaluation frameworks implementing conflict analysis will enable a quantitative understanding of safety measure performance, accelerate adoption of safer intersection designs and provide justification for safety investments.

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## Implementation and evaluation of Area 40 in Maribyrnong – findings and lessons to date

Lisa Steinmetz<sup>a</sup>, Eng Hwa Lim<sup>b</sup>

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### Abstract

As part of Council's Safer Local Roads program, Council has commenced implementation of 40 km/h area speed limits throughout the municipality. The City was divided into 7 areas where the sequence of Area 40 implementation generally aligns with the Local Area Traffic Management Program. To date, reduced limits have been implemented in 5 out of 7 areas – the Seddon and Yarraville precinct (Area 2), Footscray (Area 1), Kingsville (Area 3), Braybrook, Maidstone and West Footscray (Areas 4 and 7). Post-implementation evaluation forms part of this overall program. This paper presents the approach and the results of the evaluation for the first Area 40 in Seddon and Yarraville. The short-term evaluation (undertaken less than 12 months after the treatment implementation) provides insights into impacts the speed reductions have had on safety, driver behaviour and operations.

### Extended Abstract

#### *Introduction and background*

Maribyrnong City Council is seeking to improve road safety as well as encourage increased walking and cycling within the local community. Council's Safer Local Roads program includes implementation of 40 km/h area speed limits throughout the municipality. Implementation of Area 40 is being progressively rolled out, with the City having been divided into 7 precincts (see Figure 1). To date, reduced limits have been implemented in 5 out of 7 areas – the Seddon and Yarraville precinct (Area 2), Footscray (Area 1), Kingsville (Area 3), Braybrook, Maidstone and West Footscray (Areas 4 and 7).

Post-implementation evaluation forms part of this overall program. In line with this, a short-term evaluation (undertaken less than 12 months after the treatment implementation) for the first Area 40 in Seddon and Yarraville (Area 2) has been undertaken to provide insights into impacts the speed reductions have had on safety, driver behaviour and operations.

The speed limit changes implemented in Area 2 entailed:

- 40 km/h area speed limit to all local and collector roads
- 50 km/h speed limit along Hyde Street between Napier Street and Francis Street, as well as on the arterial roads Buckley Street/Napier Street, Williamstown Road/Geelong Street and Francis Street.

#### *Findings*

The evaluation found that implementation of reduced speed limits in Seddon and Yarraville has resulted in reduced speeds (both mean and 85th percentile) for most streets. Where speeds reduced, the average reduction in mean speeds was 1.3 km/h and the average reduction in 85th percentile speeds was 1.5 km/h (for both free-flowing conditions as well as all vehicles).

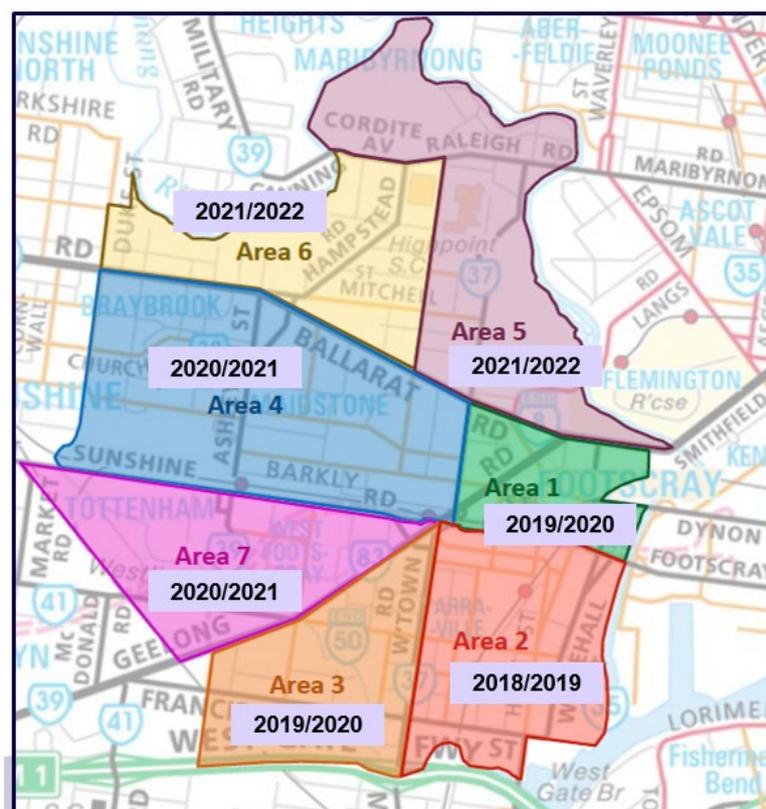
An analysis of vehicles travelling under free-flowing conditions was undertaken to consider the true effectiveness of the reduced speed limits, that is, when drivers are able to select their travel speed. This analysis showed speeds of vehicles travelling under free-flowing conditions reduced by a greater amount compared to the change for all vehicles.

The expected change in casualty crashes due to the reduced speed limits was modelled using Elvik's Revised Power Model. This approach enabled the road safety benefits to be estimated within one year of treatment implementation, rather than the  $\geq 5$  years generally required for a suitable level of confidence in changes to crashes. The model estimated 2.4% fewer casualty crashes where speed limits were reduced from 50 km/h to 40 km/h and 6.9% where speed limits were reduced from 60 km/h to 50 km/h. This represents an expected reduction of 5.3 casualty crashes in the study area over five years.

### *Next steps*

For subsequent Area 40 precincts, potential control data sites have been identified. Use of control sites will enable the effects from external factors (such as weather and other seasonal conditions) or regression to the mean to be accounted for.

Future (medium and/or longer term) evaluations should be undertaken to assess the longer-term effectiveness of the treatment. Future evaluations and the Council's complementary Local Area Traffic Management program can monitor and inform the success of Maribyrnong City Council's Safer Local Roads program to improve road safety as well as encourage increased community walking and cycling. As part of the recently endorsed Road Safety Strategy and Action Plan, council will be researching the effectiveness of 30 km/h speed limit from recent trials within Australia and investigate potential for further reduction to 30km/h on local streets within key activity centres with high pedestrian and cycling volumes in coordination with Department of Transport.



**Figure 1.** Maribyrnong 40 km/h speed zone precincts

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## Improving the Evaluation of Victoria's Road Safety Program

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### Abstract

Before and after evaluations of road safety infrastructure programs provide valuable feedback to transport departments on how effective their programs have been in reducing deaths and serious injuries. With the goal of Vision Zero it is more important than ever to understand which programs and projects are effective and those which are not. The Victoria Department of Transport have been doing evaluations of their extensive road safety programs since the 1990's. A review of the program evaluation business requirements and the methodologies that have been used to undertake previous evaluations has identified some shortcomings and potential improvements. There are best practice methods used in other countries, and especially in North America, that have been shown to provide more robust evaluation results. This study recommended changes in the statistical methods used in future evaluation studies, including use of the empirical Bayes method.

### Background and Purpose

In road safety, formal post construction program evaluation studies generally involve a before and after study of crash data. Such studies provide valuable information on how effective safety programs and specific treatments have been in reducing crashes, and particularly fatal and serious injury crashes.

Victoria has had a strong commitment to carrying out such studies at regular intervals since the 1990's. A recent review, however, has identified that the evaluation methods being used in Victoria could be improved to make them more precise. The main purpose of this study was to identify preferred future evaluation method(s) through assessing the previous, and some new, before and after study methodologies. A secondary purpose of the study was to identify other improvements that could be made to the evaluation outcomes.

### Description

In this study we identify 11 different methods that have been used in the road safety and other fields (see Table 1). We also identified the key issues, like regression-to-the-mean, road user adaptation, and changing road user volumes, that need to be addressed in the analysis.

An assessment was then made on how well each method dealt with the main issues. The traditional approaches that have been used in the Victorian evaluations have some shortcomings, which some more advanced methods do address. The preferred state-of-the-art method, however, does require considerable data and investment in money and time to enable the production of safety science tools (like the development of Safety Performance Functions), and so is not available for immediate application. Hence the study considered which methods were preferable in the short and medium term (see Table 1, which shows the priority methods overall and short-term).

The Safer Roads Program Evaluation Working Group also identified some other improvements that could be made to the evaluation process. One area of interest is the need to understand the effectiveness of treatments on the more serious of the serious crashes (MAIS 2/3 plus), rather than just on all serious crashes. The paucity of such crashes further emphasizes the need for rigour in the evaluation methods.

## Conclusion

The study identifies a number of key issues that need to be addressed by the preferred evaluation method(s). Generally, for most programs and treatment there is an overestimation of safety benefits due to not accounting for the regression-to-mean effects. This results when the analysis method is not adequately factoring in the reality that the number of crashes will reduce at sites selected because they had a high crash frequency, even if no treatment is applied. There is a substantial body of research that indicates that regression to the mean effects are not trivial and can be of the same order as the true effects of many safety treatments. Hence there is a need to move to the preferred empirical Bayes method in order to best account for regression-to-the-mean.

Method Number	Evaluation Method	Pros and Cons	How does this account for regression-to-the-mean
Method 1	MUARC – the method used in the SRIP1-SRIP3 MUARC reports	Pros: Simplicity. Cons: A lengthy (at least five year) data collection period is needed	This method aims to neutralise RTM concerns by collecting data over a sufficiently large number of years.
Method 2	Hauer and Persaud “Non-parametric” method	Pros: Simplicity; does use a mixture model, though with a uniform distribution on unsafety Cons: Limited accuracy [11, p.43]	Neat statistical theory provides a formula for correction. A strong assumption, however, is made.
Method 3 (preferred short term)	Beca (SRIP 3 Phase 3): Graphical presentation of confidence intervals for crash numbers in periods prior to treatment	Pros: Simplicity and robustness Cons: Data must be aggregated coarsely; a univariate normal model underlies the graphic	RTM on a broad scale can be readily seen in the graphic.
Method 4	Beca (SRIP 3 Phase 3): Binomial Method	Pros: Simplicity. Theory for producing crash rate confidence intervals is available. Cons: Only useful for a subset of crashes	It is unique amidst methods here in that it strengthens an <i>existing</i> RTM- corrected crash rate.
Method 5	RTM correction of crash rates above a nominated threshold	Pros: A formula is available for correcting individual data observations, above a set threshold, for RTM. Cons: Crash counts must be aggregated sufficiently for normality of their distribution to be assumed. (This is not demanding – a Poisson distribution with mean greater than ~15 is approximately normal.)	RTM correction is possible through use of a simple formula
Method 6 (preferred short term)	Plots of After-Before difference against Before	Pros: Simplicity and robustness Cons: Most effective if data is normally distributed. Transformation of skewed data can be used to improve this.	RTM is seen in the slope of the fitted straight line. Treatment effectiveness is also seen in vertical displacement of a fitted line.

Table 1 (a) – Evaluation Methods 1 to 6

Method Number	Evaluation Method	Pros and Cons	How does this account for regression-to-the-mean
Method 7	Method 6 but for individual site crash count data	Pros: A quick visual summary of RTM and treatment effectiveness. Cons: Data transformation to improve normality is possible – for example, using the square root transformation	Same as Method 6
Method 8 <b>(preferred back-up)</b>	Poisson-gamma mixture model, fitted using empirical Bayes methodology	Pros: Only crash data, individual or aggregated, is needed – no explanatory variable data for sites need be collected. Cons: The SPF is not produced. A caution: to be effective, crash rates must be available for a population of sites with characteristics similar to the sites chosen for treatment. This must provide sufficient sites to enable reasonable estimates of the parameters of the prior unsafety distribution.	Uses the gold standard “posterior mean” of the Poisson-gamma mixture model to correct for RTM.
Method 9 <b>(preferred overall)</b>	Poisson-gamma mixture model, fitted using generalised linear model methodology	Pros: The SPF is produced; parameters needed for individual site RTM correction are produced as a by-product of the GLM fitting. Cons: Possibly extensive quality data collection of site variables is required.	Uses the gold standard “posterior mean” of the Poisson-gamma mixture model.
Method 10	Poisson-gamma mixture model fitted using a Bayesian method (e.g. MCMC)	Pros: May be useful when few control sites available [12] Cons: Prior distributions on all parameters needed. Computationally complex and may present algorithm convergence challenges. Not for the faint-hearted.	Again, uses the gold standard “posterior mean” of the Poisson-gamma mixture model.
Method 11	Method 8 for amalgamated site data	Pros: Aggregated crash data is needed – no explanatory variable data for sites need be collected. Cons: The SPF is not produced.	A formula for RTM correction would be developed. It would refine the formula developed in Method 5.

Table 1 (b) – Evaluation Methods 7 to 11

## **Safer roads black audio tactile line marking short term evaluation**

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### **Abstract**

Black Audio Tactile Line Marking (ATLM) has been implemented on a range of rural roads as a component of the Safer Roads programme. ATLM is intended to reduce serious casualties caused by head-on and run-off-road crashes.

A longitudinal analysis was conducted to determine if any significant change had occurred across four treatment sites and six control sites. The collection of traffic data included Automatic Traffic Counts (ATCs) and video camera surveys to observe driver speed behaviour and lane placement.

The camera survey sites provided the most tangible evidence that the Black ATLM treatment is effective at modifying driver behaviour. Lane positioning variability significantly reduced in at least one direction at the treatment sites, compared to none at the control site. Similarly, duration of lane encroachment and passing vehicle separation had some significant results at the treatment sites, however more data is needed to verify the ATLM impact on these variables.

### **Background**

The Safer Roads programme, funded by the Transport Accident Commission (TAC) and managed by Department of Transport (DoT), aims to deliver a broad range of road safety improvements to realise the “Toward Zero” vision championed by the Victorian State Government.

The key goals of the Safer Roads programme are to significantly reduce the most common types of crashes occurring on Victorian roads including vehicles leaving the road, head-on collisions, side impacts at intersections and collisions with pedestrians and cyclists. Black ATLM is currently being implemented on a range of rural, two-way roads as a component of the Safer Roads programme. ATLM is intended to reduce serious casualties caused by head-on and run-off-road crashes.

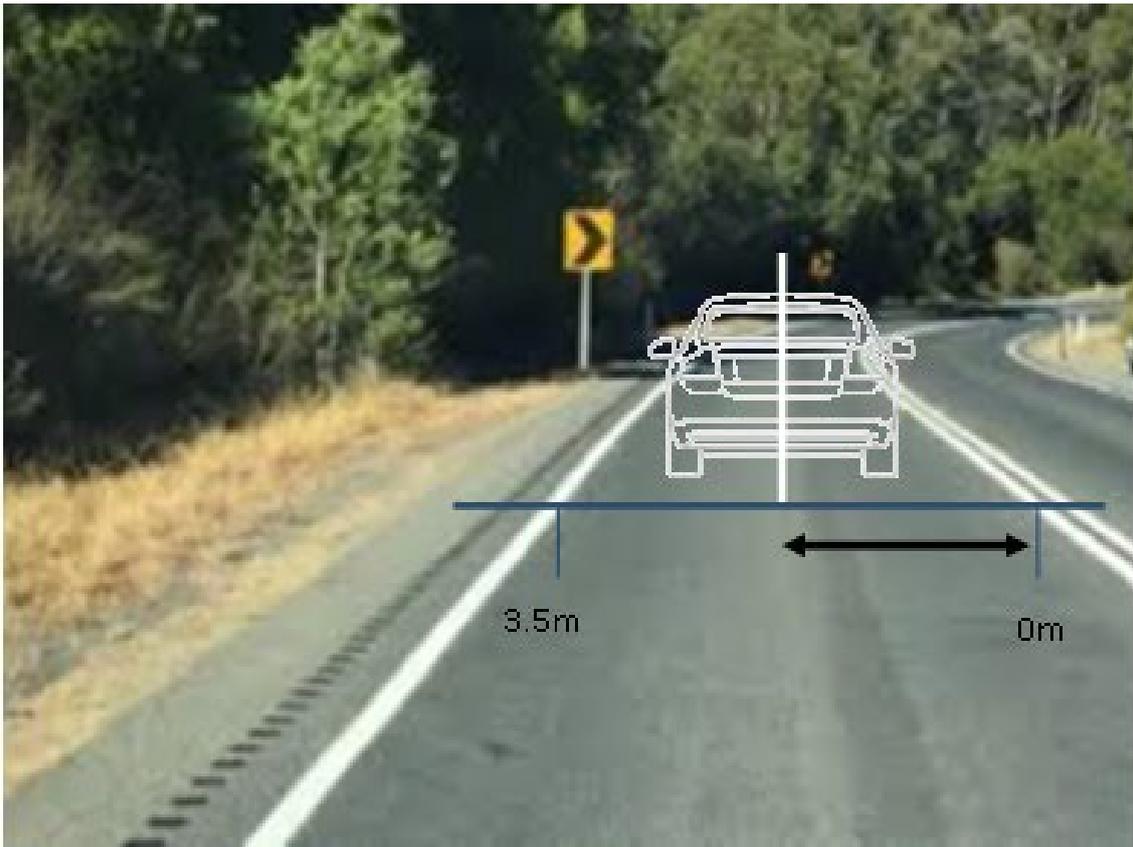
The ATLM treatment involves raised thermoplastic ribs adjacent to the centre-line and/or edge-line which cause noise and vibration when driven over. The treatment is black and varies from traditional white ATLM which is provided on longitudinal linemarking. The treatment alerts drivers when the vehicle drifts out of the lane and encroaches onto either the opposing lane or the road shoulder.

### **Evaluation**

Five sites were originally selected as Treatment sites and five sites chosen as Control sites. However, one site was removed from scope by DoT between the ‘Before’ and the ‘After’ surveys being conducted, reducing the evaluation to four treatment sites and six control sites.

This evaluation project involved the collection of traffic data including ATCs to record vehicle volumes, speeds, and travel times as well as video camera surveys to observe driver behaviour. Two treatment sites and one control site were selected for video camera surveys.

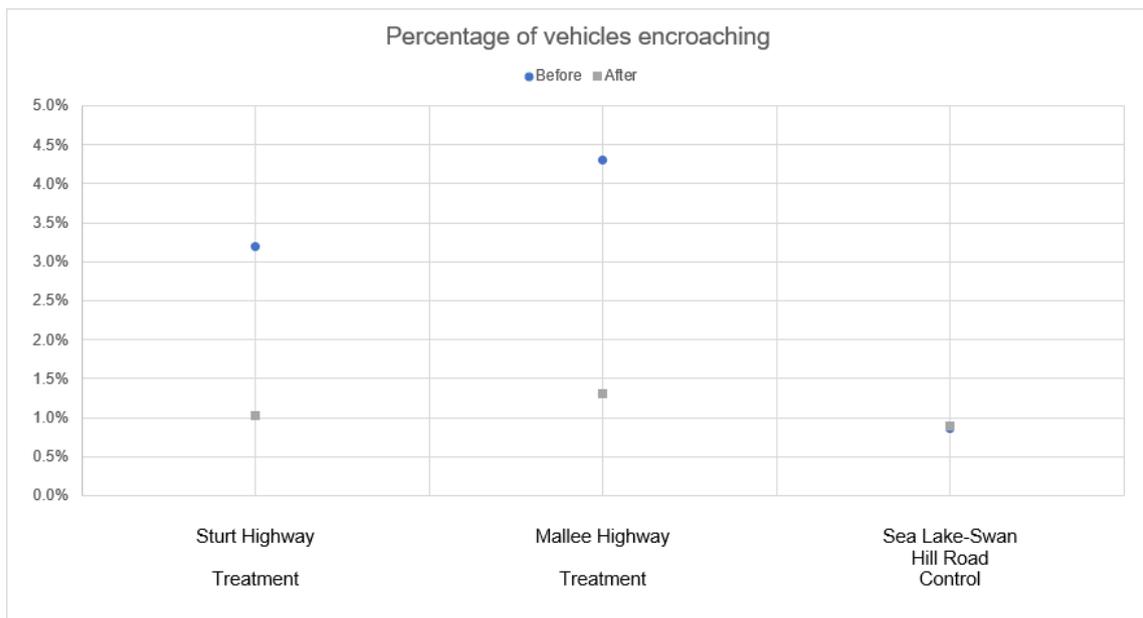
A longitudinal analysis was conducted, with statistical tests performed to determine if any significant change had occurred.



**Figure 1.** Lane Positioning Diagram

**Effectiveness**

The camera survey sites provided the most tangible evidence that the Black ATLM treatment is meeting project objectives. Figure 2 presents a summary of the percentage of vehicles encroaching in the ‘Before’ and ‘After’ surveys. The results suggest that the ATLM treatment was effective at reducing the number of lane encroachments.



**Figure 2.** Percentage of Vehicles Encroaching ‘Before’ and ‘After’ Comparison

Lane positioning variability significantly reduced in both directions at Sturt Highway and in one direction at Mallee Highway suggesting the ATLM treatment had some impact. Similarly, duration of lane encroachment and passing vehicle separation had some significant results in reducing encroachment time, however more data is needed to verify the ATLM impact on these variables.

No statistically significant changes in AADT volumes, speeds, or travel times were found to be attributable to the black ATLM treatment, and as such have been attributed to wider network behavioural changes.

### **Next steps**

There are statistically significant results suggesting the black ATLM treatment meets the expected treatment benefits. GHD make the following recommendations to enhance the understanding of black ATLM benefits further:

- Longer duration camera surveys to be undertaken, across a larger number of treatment sites
- Analysis of vehicle response after they engage with the ATLM treatment
- A comparative analysis between white and black ATLM

## Short-term Evaluation of Raised Safety Platforms: A Preliminary Analysis based on Vehicle Speeds

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### Abstract

Raised Safety Platforms (RSPs) have been installed to reduce the speed of traffic entering intersections with a view to reducing fatal and serious injury (FSI) crashes. A before and after study with control sites was used to compare traffic performance prior to and after the installation of RSPs at treated intersections along two arterial routes. Statistically significant reductions in speed were found at all treated intersections, and in most cases these reductions were substantial. After treatment and adjusting for changes in the control group, there was an 80% reduction in the odds of a vehicle on the main road exceeding the Safe System threshold of 50 km/h for cross-traffic collisions - the percentage of vehicles exceeding this speed reduced from 32% to 7%. There was also a 46% reduction in the odds of exceeding 30 km/h. Crash reductions estimated on the basis of the speed reductions were 24% for vehicle to vehicle crashes. Substantial reductions in the risk of injury to vulnerable road users and other dominant crash configurations were also identified. It was concluded that RSPs were an effective countermeasure for intersections, and that they could be used in similar situations with confidence, but long-term monitoring was required to determine their crash reduction factor based on real crashes.

### Background

The Safe System Road Infrastructure Program (SSRIP) of the Department of Transport has installed two forms of Raised Safety Platforms (RSPs) – fully raised intersections and Raised Stop Bars (RSBs) – at selected signalised intersections in the Thomastown region of the Melbourne metropolitan area. These aim to reduce the number of crashes and serious injuries primarily by reducing speeds at the intersections, and also by reducing red-light running events and improving braking profiles. The evaluation involved fully raised intersections at three sites, RSBs at three sites, and one further site which was converted to a signalised control along with the installation of a RSB. Before/after differences in speed at these sites were compared with before/after differences at five control sites located in the same geographical area.

### Methods

The evaluation involved RSPs at seven treatment sites, together with five control sites. Speed measurements were collected using conventional pneumatic tubes and classifying counters. Speeds were measured at three approach points and two departure points on each leg of each intersection; results from the last entry measurement point and the first departure point on the main approach are reported in this paper. These are the key points for assessing the impact of the RSPs, being closest to the impact point in an intersection collision. Before speed measurements are compared with speed measurements 6-8 weeks after the RSPs were installed. Analysis was conducted in terms of mean speed, and percentages of vehicles exceeding the Safe System critical speeds of 50 km/h (for side impacts) and 30 km/h (for vulnerable road user impacts). Regression techniques were used to adjust changes in speed observed at the treated site for changes observed at the control sites, along with other potential confounding factors.

## Results

Speed reductions were evident for all approach and departure measurement points at the treated intersections (see Table 1). All reductions were statistically significant, and most reductions were substantial. At the five control intersections, speeds showed small increases at three intersections and reductions at two of the intersections. The reductions were generally considerably smaller than the reductions achieved at the treatment intersections. Reductions at treatment sites averaged 8.5 km/h for the entry speed and 3.0 km/h for the departure speed.

Significant reductions in the percentage of vehicles exceeding the nominal Safe System speed levels of 30 km/h (applicable to collisions with pedestrians and cyclists), and 50 km/h (side impact with a vehicle) were observed on the approaches to the treated intersections (Table 2). The percentage of vehicles exceeding 50 km/h reduced substantially, from around 32% before treatment to just over 7% after treatment. This was statistically significant ( $p < 0.05$ ), with a regression model indicating an 80% reduction in the odds of a vehicle exceeding this Safe System speed. This was reassuring, given that higher speeds mean more severe injuries in a crash for both vehicle occupants and vulnerable road users. A 46% reduction in the odds of a vehicle exceeding the Safe System speed for vulnerable road users (30 km/h), was also identified.

## Expected Crash Reductions

The crash reductions which could be expected as a result of the treatments were estimated based on extensive bodies of previous work relating crash occurrence to speed. Based on the work of Elvik et al. (2019) a reduction in fatal and serious injury (FSI) crashes of 24% was estimated. Based on curves relating pedestrian injury to impact speed from Davis (2001), a reduction in pedestrian FSI crashes of between 18% and 56% across the different sites was estimated. Reductions in the likelihood of a serious injury (MAIS3+) given the occurrence of five dominant two-vehicles collision configurations were also identified. These included a 61.4% reduction in the odds of an injury given a collision between a through vehicle and a right-turning vehicle on the main road.

## Conclusions

These results show that substantial speed reductions were achieved following the installation of the RSPs, ranging from as little as 1.6 km/h to 13.6 km/h. Reductions at the site which combined signalisation with the RSB and at the intersections which used RSBs were within the range of the reductions achieved with RSBs at already-signalised intersections.

Reductions in the percentages of vehicles exceeding 50 km/h were also statistically significant and substantial. After installation, across all intersections, only 7% of vehicles entered the intersection at more than 50 km/h, the threshold speed for serious injuries in cross-traffic collisions. Modelling of crash outcomes based on the speed reductions indicated a reduction of 24% in FSI crashes could be expected.

The raised platforms at intersections therefore appear to be effective in reducing traffic speeds to levels close to those required by Safe System principles for situations in which there is a risk of cross-traffic collisions. Raised platforms can be used at situations where they are warranted with a degree of confidence that they will improve safety.

The treated intersections, and any further installations, should be closely monitored over the long term to determine their crash reduction factor based on crash data, and how closely that approximates to the crash reductions expected on the basis of speed reductions.

**Table 1. Changes in median speed at the approach measurement point closest to the centre of the intersection for treatment and control intersections, before and after RSP installation**

Site	RSP type	Approach			Departure		
		Mean speed (km/h)		Difference	Mean speed (km/h)		Difference
		Before	After		Before	After	
<b><i>Treated sites</i></b>							
T2 Dalton Road and Alexander Avenue	Raised stop bars on all approaches	46.3	32.7	-13.6	50.1	46.8	-3.3
T3 Dalton Road and The Boulevard	Raised stop bars on all approaches	43.5	34.0	-9.6	48.5	47.9	-0.7
T4 High Street and Spring Street	Fully raised intersections	44.8	38.8	-6.0	44.4	40.8	-3.6
T5 High Street and Station Street	Fully raised intersections	40.1	31.8	-8.3	43.8	34.8	-8.9
T6 High Street and Main Street	Fully raised intersections	39.2	37.7	-1.6	38.0	34.9	-3.1
T7 High Street and Cooper Road	Raised stop bars on all approaches	39.0	31.7	-7.2	43.7	41.4	-2.3
<b><i>Treatment + signalisation site</i></b>							
T1 Dalton Road and Spencer Street	Raised stop bar just on Dalton approach.	50.4	33.2	-16.4	50.8	44.1	-6.7
<b><i>Control sites</i></b>							
C1 Edgars Road and Cooper Street		33.6	33.9	0.3	41.8	44.3	2.5
C2 Edgars Road and Main Street		41.5	42.4	0.9	45.2	47.1	1.8
C3 Edgars Road and Spring Street		57.1	54.9	-2.2	57.4	56.3	-1.0
C5 High Street and Kingsway Drive		48.8	46.0	-2.9	47.0	44.6	-2.4
C6 High Street and Murray Road		29.7	30.5	0.8	30.8	30.9	0.1

**Table 2. Changes in the percentage of vehicles exceeding Safe System thresholds for pedestrians and cross-traffic collisions, before and after RSP installation**

Group	Approach			Departure		
	Before	After	Difference (%)	Before	After	Difference (%)
Percentage of vehicles exceeding <b>30 km/h</b> (pedestrians)						
Treated sites	78.4%	65.8%	-12.6% (-16.1%)	89.6%	84.5%	-5.1% (-5.7%)
Control sites	81.9%	80.9%	-1.0% (-1.2%)	84.7%	86.6%	1.9% (2.2%)
Percentage of vehicles exceeding <b>50 km/h</b> (cross-traffic)						
Treated sites	32.2%	7.2%	-25.0% (-77.6%)	32.1%	17.5%	-14.6% (-45.5%)
Control sites	50.7%	45.9%	-4.8% (-9.5%)	36.4%	42.0%	5.6% (15.4%)

## Funding

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## Developing safe system projects and programs using safety science methods

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### Abstract

The Victorian Safer Roads program strives to eliminate road traffic fatalities and serious injuries across the State through the cost-effective implementation of safe system compliant road safety infrastructure and speed management programs and projects. To maximise the benefits of the Safer Roads program it is important that any safety countermeasures are well targeted to the highest risk sites and routes. This relies on using statistically robust methods in both site selection and project appraisal, that adequately account for statistical variation in crash data. This study identified the gaps/weaknesses in the current road safety project and program development methods used by Safer Roads and assessed the various options that are available to address these shortcomings. This study established the need to move away from relying solely on historical crash data and a move towards the empirical Bayes method, that use both historical crash data and predictive crash analysis methods, based on safety performance functions (SPFs) and crash modifying factors (CMFs). This preferred method is often referred to as the safety science, or the USA Highway Safety Manual (HSM), approach.

### Background and Purpose

Developing high-priority, effective and safe system compliant program and projects is a core, vital capability of the Victorian Safer Roads program. A recent review identified that there was a need for Safer Roads to use more statistically robust methods in the selection of project sites, that accounts for statistical variation in crash data. Based on expert advice it was also identified that the traditional appraisal methods used to assess the effectiveness of safety countermeasures were also not statistically robust. The purpose of this study was to identify more statistically robust methods to select project sites, along with establishing better methods to estimate the likely safety benefits of projects and programs.

### Description

Traditionally the selection of sites for treatment have predominately been based on historical crash data. The sites with the highest crash numbers often get prioritised for treatment. This is still a common practice used around the world, despite its shortcomings. During this study we confirmed through workshops and interviews with DOT staff that the majority of sites selected for treatment in Safer Roads Investment Programs are primarily based on recent crash history and local knowledge. However, in many cases other factors, such as community acceptance of treatments, are also key considerations.

Historical crash observations are subject to considerable variability and so many high crash site observations do not reflect the underlying crash risk. Many high-risk sites are subject to regression-to-the-mean, where crash rates go down in preceding years, even if no treatments are applied. The reverse is also true, that some high-risk sites may have a low number of crashes in a given period and crash rates go up in preceding years. This creates three issues for safety analysts, 1) that some of the sites with recent high crashes don't justify treatment, 2) that some high-risk sites are not identified for treatment, due to recent low crash numbers and 3) that the crash reductions estimated at sites subject to regression-to-the-mean may be overstated (as the crash reductions are applied to high crash rates that don't reflect the underlying crash risk). The reliance on historical crash data alone does led to errors in identifying the highest risk sites long-term and in the estimation of the effectiveness of road safety treatments.

The study identified the need to move towards use of more predictive crash analysis methods, such as safety science methods, which use safety performance functions (SPFs), crash modifying factors (CMF) along with historical crash data (using the empirical Bayes method), or to iRAP type tools, like ANRAM. Both methods have been applied in a limited way by Safer Roads to rural roads. Based on over two decades of use in the USA and Canada, the empirical Bayes method is considered the preferred method going forward, especially in urban areas.

The empirical Bayes method does however require the development of many safety performance functions (SPFs) and reliable crash modification factors (CMFs). The study did consider the data requirements of building and applying these tools. Some data is readily available while some, for example vulnerable road user volumes, would need to be collected. Based on the key areas identified for safety investment (high speed roads, high risk intersections, mixed use roads and low speed roads) the priority area for developing SPFs and CMFs has also been identified (green areas in Table 1). Initially the focus would be on develop very basic SPFs. In the medium and long term this should include the development of more enhanced and full-specified SPFs and associated CMFs.

**Conclusion**

This study identified the need to move away from relying on crash history alone for ranking sites for treatment and also for appraising the benefits of projects. Safety science methods, such as the empirical Bayes method, which use quality SPFs and CMFs along with crash data are considered statistically robust methods, and hence are expected to address the concerns identified with current methods.

INVESTMENT AREA	SUB-INVESTMENT AREA	IMMEDIATE	SHORT TERM	MID TERM	LONG TERM
I HIGH SPEED ROADS	HIGH SPEED RURAL ROADS	Empirical Bayes	ENHANCED SPF	ENHANCED SPF	FULL SPF FOR VIC & CRASH DATA
	HIGH SPEED RURAL ROADS – LOCAL ROADS	Crash History – FSI Equivalent	ANRAM FOR LOCAL ROADS	CALIBRATED IRR	ENHANCED SPF
II INTERSECTIONS	INTERSECTIONS – RURAL	Crash History – FSI Equivalent	BASIC SPF (TRAFFIC VOLUME & SPEED) & CRASH DATA KIWI SPF CALIBRATED FOR VICTORIAN INTERSECTIONS & CRASH DATA	FULL SPF FOR VIC & CRASH DATA	FULL SPF FOR VIC & CRASH DATA
	INTERSECTIONS – URBAN	Crash History – FSI Equivalent	BASIC SPF (TRAFFIC VOLUME & SPEED & VRU LEVEL) & CRASH DATA	KIWI SPF CALIBRATED FOR VICTORIAN URBAN INTERSECTIONS & CRASH DATA FULL SPF FOR VEH TRAFFIC & CRASH DATA; FULL SPF FOR PED & CRASH DATA; FULL SPF FOR CYC TRAFFIC & CRASH DATA	FULL SPF FOR VEH TRAFFIC & CRASH DATA; FULL SPF FOR PED & CRASH DATA; FULL SPF FOR CYC TRAFFIC & CRASH DATA
III MIXED USE ROADS	ARTERIAL LENGTHS – VEHICLES	Crash History – FSI Equivalent	BASIC SPF (TRAFFIC VOLUME & SPEED) & CRASH DATA	Full SPF for Vic & Crash Data	Full SPF for Vic & Crash Data
	ARTERIAL LENGTHS – PEDESTRIANS	Crash History – FSI Equivalent	BASIC SPF (TRAFFIC VOLUME & SPEED & PED CROSSING LEVEL) & CRASH DATA	Full SPF for Vic & Crash Data	Full SPF for Vic & Crash Data
	ARTERIAL LENGTHS – CYCLISTS	Crash History – FSI Equivalent	BASIC SPF (TRAFFIC VOLUME & SPEED & CYCLING VOLUMES LEVEL) & CRASH DATA	Full SPF for Vic & Crash Data	Full SPF for Vic & Crash Data
IV LOW SPEED ROADS	LOCAL STREETS	Crash History – FSI Equivalent	BASIC SPF (TRAFFIC VOLUME & SPEED & VRU LEVEL) & CRASH DATA	Basic SPF (traffic volume & speed & VRU Level) & Crash Data	Assess the Need for a Full SPF for Vic & Crash Data

## Vision zero for p-hailing riders: understanding work demands and unsafe work behaviours

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### Abstract

Looking at worrying trend of accidents among p-hailing riders, which refers to the delivery of parcels and food via online applications using motorcycles, it is essential for us to set out strategy to curb the accidents. As part of Malaysia's Vision Zero Program, this study identifies the roles of working conditions in influencing their safety risks and examines how safety becomes riders' top priority. An online survey was conducted and the results of 100 respondents showed that the desire to get attractive income has forced them to work long hours with insufficient rest time and persuade them to violate traffic rules more often. Besides, the riders ride dangerously at peak hours to avoid negative response from customers. The findings will be used as baseline information for conducting training to increase riders' safety awareness in line with the government strategies on regulating the service under existing laws.

### Background, Methodology, Results and Conclusions

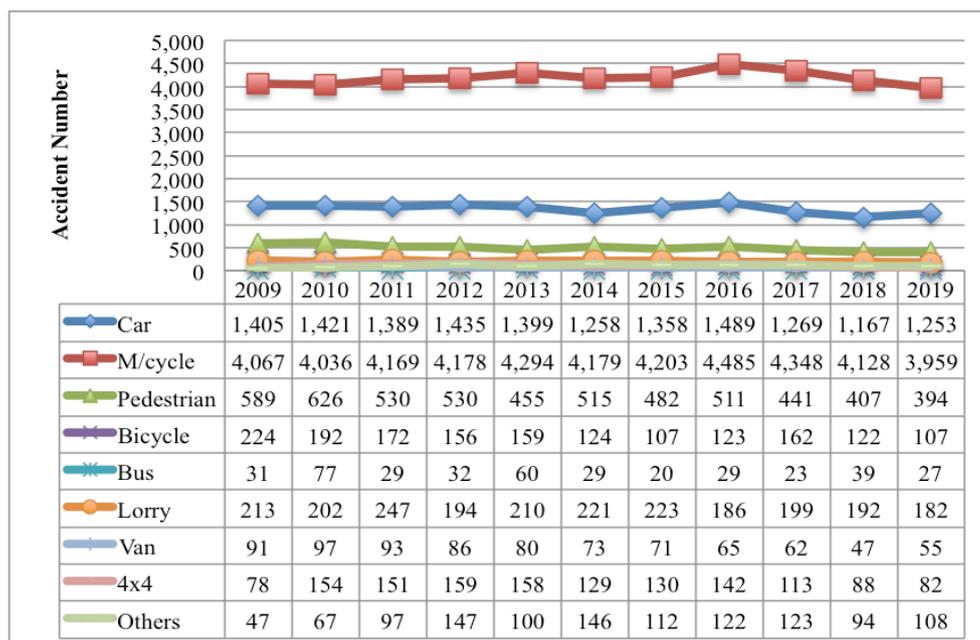
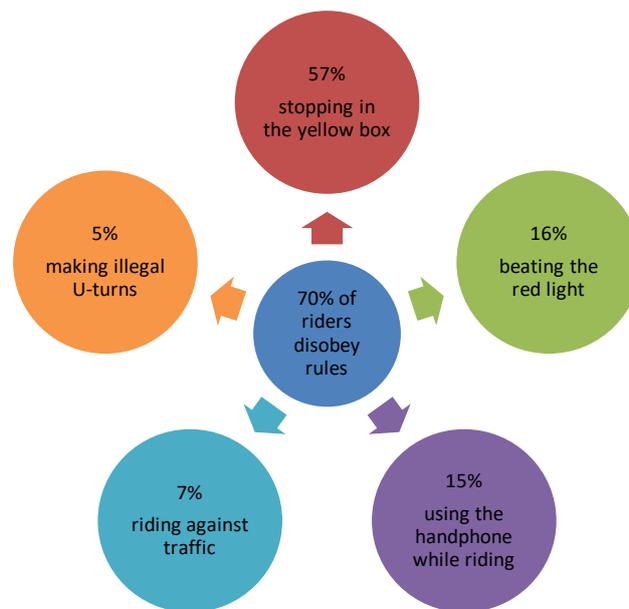


Figure 1: Road Accident according to Vehicle Categories, (MOT et al., 2019)

In 2020, road accident is the 4<sup>th</sup> leading cause of death that contributed to 3.8% of the overall causes and 20.6% involve citizens among 15 to 40 years old (DOSM, 2020). Figure 1 summarises the road accident according to vehicle categories for 2009 to 2019. Motorcycles are the major contributor to road accident which reported cases of 3959 in 2019. According to (MSOSH, 2020), the majority of motorcyclist accident victims suffer 30%, 25%, 9% and 4% of head, leg, hand and chest injuries respectively.



**Figure 2: Percentage of riders disobeyed traffic rules ((MIROS, 2021)**

A total of 2576 death involving motorcyclists was reported within 9 months after the ‘lockdown’ was imposed on March 18 2020 (MIROS, 2021). In 2020, from approximately 60,000 p hailing riders (delivery services of parcels and food items using motorcycles), there were 91 accidents were recorded with 17 deaths, 10 major injuries, and 64 minor notwithstanding the reasonably clear roads during the ‘lockdown’ period. Conversely, only 5 cases were reported in 2019. (MIROS, 2021) also found that 70% of riders disobeyed traffic rules when they were doing a delivery run and majority of them stop in the yellow box (Figure 2).

Malaysia's Vision Zero strategy headed by Social Security Organisation (SOCSO) was officially launched in 2019 aims to progressively reduce and eventually eliminate all traffic fatalities or serious injuries on roads. The program integrates and leverages a 3'E' approach; Engineering, Enforcement and Education into a single framework to maximize key resources and optimize deliverables and is carried out in collaboration with relevant government agencies such as the Royal Malaysia Police. To support Malaysia's Vision Zero strategy, a program focusing on p-hailing riders aims at reducing road accidents at high risk and accident-prone locations was introduced. As part of the program, we begin with a pilot study by distributing questionnaires to identify the roles of working conditions in influencing their safety risks and examine how safety becomes riders’ top priority. An online survey was used to record opinions of 100 respondents. The analysis showed that the p-hailing riders ride dangerously at peak hours to avoid negative response from customers who are impatient and want their food delivered to them as fast as possible. Moreover, the desire to get attractive income has forced them to work long hours with insufficient rest time and the pressure of having many orders have put them in a condition to violate traffic rules such as speed limits and increase the use of mobile phones while riding.

The findings provide the basis for the development of a training module that addresses traffic rules in general (including those commonly violated in particular and consequences of such violations), use of the right safety equipment (and the right use of them) and safe loading of two-wheeled vehicles in line with the government strategies to regulate the service under existing laws, to intensify road safety campaigns among all stakeholders and to incentivize players.

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## Identification of road accidents severity ranking by integrating the Multi-Criteria Decision Making approach

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### Abstract

This research aims to advance a novel road accident severity ranking integrating the injuries types. The injury severity data of 29 numbers of Indian states (i.e. Andhrapradesh, Arunachal Pradesh, Bihar, etc.) for the year 2019 was incorporated to formulate the severity ranking by using Multi-Criteria Decision Making (MCDM) methods. Analytical Hierarchy Process (AHP) and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) methods were taken into the application for research synthesis. The integration of MCDM methods incorporates the injury severity data with the ranking analysis. Further analysis proved the validity of the proposed research by collectively analyzing the variety of injury severity data within the single ranking approach, which often analyzes individually. Therefore to develop a novel approach, this research is resulted with great accuracy and has a great potential for reforming the conventional severity ranking practice.

### Defining the demonstrated research practice

Generally, the accident severity ranking is formulated by placing the total accidents data of study sites in ascending order. But, it is advisable to incorporate more variety of data (i.e. injury severity data) for an effective ranking generation (Bao et al. 2012) (Bham, Manepalli, and Samaranayke 2019). Therefore, with the help of MCDM methods, 29 numbers of Indian states are organized in a hierarchy based on the accident severity types. Further, the research data has to be classified into 'Criterion' (C) and 'Alternative' (A) to apply any MCDM technique. The criterion is standards on which researchers have to judge a particular problem and the alternative are possible choices available to satisfy the research objective. For the present research, accident severity types (i.e. fatal injury accidents, grievous injury accidents, minor injury accidents, non-injury accidents) are taken as the criteria and 29 numbers of Indian states (i.e. Andhrapradesh, Arunachal Pradesh, Assam, Bihar, etc.) as the decision alternatives.

### Methodology and analysis

For the demonstrated research, two of the widely acceptable MCDM technique; the Analytical Hierarchy Process (AHP) and Technique for order preference by similarity to ideal solutions (TOPSIS) are applied for severity ranking formulation. Figure 1 represents the structure of step-wise methodology to develop severity ranking for any 'm' numbers of criteria and 'n' numbers of alternatives. Here the 'K' and 'K'' term indicated within figure represents the 'Criteria Positive Index set' and 'Criteria Negative Index set' for TOPSIS. After the data synthesis; the AHP resulted in 'Priority scores' for every alternative whereas the TOPSIS conclude the 'Relative closeness values' for each criterion. Based on these values, the researchers can provide the ranking to alternatives and conclude the severity ranking structure. Table 1 represents the alternatives with the highest severity and the top 5 highly severe alternatives. Interestingly, all the top-ranked alternatives concluded by both the MCDM methods are turning out to be very similar. The research analysis that the AHP and TOPSIS have a very simple approach and can use for accident severity ranking without much intensive data analysis. Also, both of the techniques combine a large number of data sets without any other prior statistical tests.

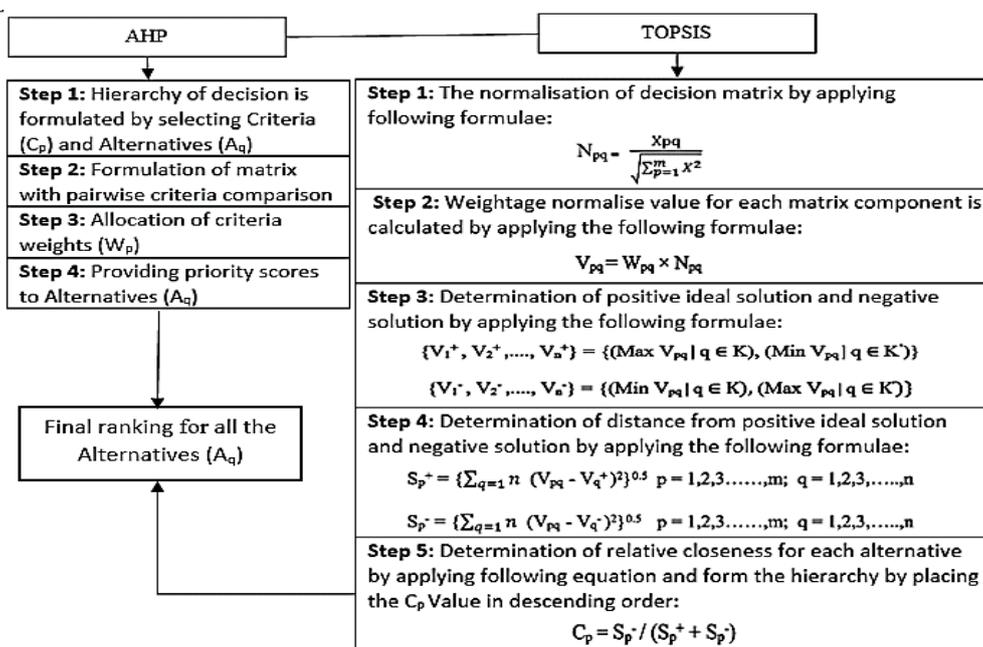


Figure 1. Step-wise methodology to implement AHP and TOPSIS

Alternatives	AHP ranking		TOPSIS ranking	
	Rank	Severity Score	Rank	Relative Closeness
Uttar Pradesh- A27	1	0.726	1	0.734
Tamil Nadu- A23	2	0.721	2	0.699
Madhya Pradesh-A13	3	0.659	3	0.677
Karnataka-A11	4	0.595	4	0.636
Kerala- A12	5	0.568	5	0.591

Table 1. Top 5 ranked alternatives with severity values

### Conclusion

The present research improves the single criteria-based ranking practices to the multi-criteria-based accident severity ranking approach. The AHP and TOPSIS proved to be very flexible and easy to use MCDM methods; so that they can be further applied for macro-level analysis of road accidents. Adding to this, the demonstrated approach is providing a novel methodology for road safety reforms to consider the multiple criteria for detailed severity analysis with the highest level of data integration. The decision-makers and government officials can use this approach by prioritizing top-ranked states for immediate road safety improvement. Also, the flexibility of MCDM modeling supports the immediate modification in the decision model, as and when required. Important criteria such as traffic volume can be added within decision multi-criteria modeling for more detailed analysis.

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## **Safety for all: Building an evidence base to support safe vehicle transport for children with disabilities and medical conditions**

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### **Abstract**

Recent research shows lack of improvement in the transportation of children with disabilities, noting they ‘continue to be inappropriately restrained in vehicles, constituting an ongoing road safety problem.’.

Mobility and Accessibility for Children in Australia (MACA) was established in 2019 to close this gap. MACA initiates research and develops policies, resources, and programs to empower a whole of system approach to meeting the transport needs of children with disabilities and medical conditions.

This presentation will include key findings from MACA’s national survey, undertaken by Curtin University. The largest and most comprehensive survey of its kind in Australia, the findings reveal stark road safety challenges for families and children with disabilities and medical conditions.

It will also introduce MACA’s new Australian Safety Assessment Program, funded by the TAC and supported by NeuRA and Britax. This world leading program develops information and prescribing advice based on assessment (including sled-crash testing) outcomes.

### **MACA’s national survey**

At MACA we believe that to move *Towards Zero*, we need to reach the furthest behind first. Real road safety outcomes for all can only be achieved when we consider the needs of our most vulnerable (Downie at al., 2019).

MACA’s vision is that every child has access to safe and equitable transport, regardless of circumstance. We drive innovation and advance the evidence base to support safe transport for children with disabilities and medical conditions.

Children with disabilities are particularly vulnerable road users with research showing they face an increased risk of injuries and fatalities in a crash compared to other children. However, until MACA was established there was no national organisation advocating for improved road safety outcomes for these vulnerable road users, resulting in a dearth of research, information, and guidance for those with responsibility and accountability for their transport.

MACA has been funded by the National Disability Insurance Scheme (2019-2022) to deliver national information resources to support the safe transport of children with disabilities. MACA’s evidence-informed website, to be launched in 2021, will provide information and tools for allied health professionals, government agencies, organisations, parents, and other stakeholders.

To advance research and knowledge, MACA collaborated with Curtin University to undertake a national survey investigating stakeholder experiences and perspectives on vehicle transport for children with disabilities and medical conditions. The survey is the largest and most comprehensive of its kind in Australia to date. A total of 488 responses were included in the analysis - 193 parents of children with disabilities/medical conditions, 234 health professionals with experience working with children with car seating needs and 61 organisations.

The presentation will detail key survey findings, revealing stark road safety challenges for families and children with disabilities/medical conditions.

### **MACA's Australian Safety Assessment Program**

Children with disabilities often require the use of products that do not comply with Australian Standards such as special purpose child restraints, vests, harnesses, cross-chest straps, extended crotch straps, and buckle covers. However, there has been limited research investigating the use of these devices and their safety performance. In comparison, Australian families have long benefited from extensive knowledge about Australian Standard child restraints, supported by regulation and community education.

With funding from the TAC and in-kind support from NeuRA and Britax, MACA has established the world leading Australian Safety Assessment Program (AuSAP).

AuSAP aims to:

- identify and meet the transport needs of children with disabilities and medical conditions.
- expand safe transport options.
- improve prescribers' knowledge and capability to prescribe in-line with the Australian prescribing standard (AS/NZS 4370).
- provide an evidence base to inform decision tools for AS/NZS 4370 prescribing practice, and educational materials for parents and organisations.
- inform standards, regulation, and policy.
- influence the design, safety, and performance of restraint products.

AuSAP will allow MACA to develop evidence informed resources and training for allied health professionals, families, suppliers, funding agencies and government.

This presentation will share the experience of the Expert Technical Team in developing the AuSAP assessment methodology - led by Vehicle Design and Research Pty Ltd. It will also outline how MACA will use this research to transform Australian allied health training and prescribing practice.

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