



Journal of the Australasian College of Road Safety

Formerly RoadWise – Australia's First Road Safety Journal



Special Issue: Global Road Safety - Part 2

Peer-reviewed papers

- Qatar's school safety program: applying Safe System principles
- Canadian legislation on excessive speeding: successful intervention through penalty increases
- Principles of road design under a Safe System

Contributed articles

- Road safety for all
- The Bloomberg Initiative for Global Road Safety 2015-2019: addressing road traffic fatalities in low- and middle-income countries
- The critical role of data, education and enforcement in road safety
- Road safety made personal, local and real: the Global Alliance of NGOs for Road Safety: an umbrella for nongovernmental organisations
- Maximising travel on 3-star or better roads: safer roads and safer speeds to deliver the 2020 UN road safety targets
- Vision Zero as a new way of thinking
- Addressing key global agendas of road safety and climate change: synergies and conflicts

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These awards will include the following presentations:

- **The prestigious Australasian College of Road Safety Fellowship Award** in recognition of an exemplary contribution being made by an individual to road safety in Australasia. This award has been recognising outstanding individuals since its inception in 1991. In 2014 the ACRS Patron, the Governor-General of Australia Sir Peter Cosgrove presented this award.
- **Australasia's premier road safety award** recognising projects that exhibit exemplary innovation and effectiveness to save lives and injuries and prevent injuries on roads – the 3M-ACRS Diamond Road Safety Awards. This award is entering its 6th year and is recognised as Australasia's premier road safety award recognising an outstanding road trauma reduction project. In 2014 the ACRS Patron, the Governor-General of Australia Sir Peter Cosgrove presented this award.

- **ARSC2016 Conference Awards** (presented in the closing session of the conference).
- **Other awards** as deemed appropriate by the joint hosts for 2016: ACRS, Austroads and the George Institute for Global Health.

We look forward to bringing you more information about the awards shortly. Most importantly we encourage your participation at this important event, which recognises our outstanding individuals, organisations and projects as we all strive to reduce road trauma.

Austroads, the George Institute for Global Health and the ACRS look forward to your participation in this important event which aligns with international, Australasian and national road safety efforts, and it is a significant step forward in Australasia's road safety strategy.

More information is available at:

<http://australasianroadsafetyconference.com.au/>

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Contents

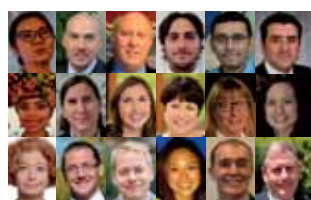
From the President	3
Guest Editorial	3
Message from UNDP Goodwill Ambassador	5
Diary.....	7
Head Office News.....	8
Chapter reports	8
Other news	10

Peer-reviewed papers

Qatar's school safety program: applying Safe System principles	
- F Marsh, M DeRoos and R Webster	11
Canadian legislation on excessive speeding: successful intervention through penalty increases	
- SA Gargoum and K El-Basyouny.....	21
Principles of road design under a Safe System	
- F Marsh and M DeRoos.....	30

Contributed articles

Road safety for all - Z Mandela	39
The Bloomberg Initiative for Global Road Safety 2015-2019: addressing road traffic fatalities in low- and middle-income countries	
- K Larson, R Bavinger and K Henning	41
The critical role of data, education and enforcement in road safety	
- G Boniface and SR Horn	43
Road safety made personal, local and real: the Global Alliance of NGOs for Road Safety: an umbrella for nongovernmental organisations	
- L Brondum	48
Maximising travel on 3-star or better roads: safer roads and safer speeds to deliver the 2020 UN road safety targets	
- R McInerney	51
Vision Zero as a new way of thinking	
- M Belin	60
Addressing key global agendas of road safety and climate change: synergies and conflicts	
- C Sakashita and RFS Job.....	62



Cover image

This collage includes photographs of the contributors to this special issue on Global Road Safety and represents the range of international road safety leaders, funders, advocates, and researchers working to achieve the UN Decade of Action and SDG targets to reduce road trauma on a global scale. Photos include from top row Left to Right: Michelle Yeo, F Marsh, M DeRoos, R Webster, S Gargoum, K El-Basyouny, Z Mandela, K Larson, R Bavinger and K Henning, G Boniface, SR Horn, L Brondum, R McInerney, M Belin, C Sakashita, RFS Job and. LauchlanMcIntosh

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The Journal of the Australasian College of Road Safety
(published as **RoadWise** from 1988-2004) ISSN 1832-9497.
Published quarterly by the Australasian College of Road Safety.

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From the President



Dear ACRS members,

It is an honour to present this edition of the Journal, the final in our two-part special focus on global road safety, compiled by our guest editors Dr RF Soames Job and Dr Chika Sakashita.

I am delighted that the UN Road Safety Ambassador Michelle Yeoh has been able to make a

contribution setting out the overall need, world-wide, to lift the level of advocacy and funding for improving road safety.

Equally it is so valuable to have contributions from high level bodies such as the Global Alliance of NGOS for Road Safety; Bloomberg Philanthropies, the International Road Assessment Program and the International Association of Police Chiefs.

As readers know, unnecessary road trauma is a major global issue. International high level advocacy to bring the issue to the attention of decision makers at the global level is essential to support and encourage regional and local leaders in their work programs to reduce road crashes and hence this unnecessary trauma.

The release of this August edition of the Journal will coincide with the 2016 Australasian Road Safety

Conference to be held soon after in Canberra, Australia in September. The College is proud to co-host this event with our Founding Partner Austroads, and to welcome The George Institute for Global Health as our third co-host for 2016. We look forward to a very full three-day event and invite you to join hundreds of road safety's leading experts across plenary panel sessions including Keynote presentations, 150 concurrent sessions, 11x 90-minute special focus Symposia, poster presentations, and social functions including the Conference Dinner at Parliament House. I am delighted to pass on news that the College Patron, Governor-General Sir Peter Cosgrove, will be joining us at the Welcome Reception at the Australian War Memorial.

As College President I encourage all road safety stakeholders to join us at ARSC2016 to learn about the latest research and programs making an impact on road trauma outcomes, take advantage of the opportunity to network with your fellow road safety peers, and take a moment to look back and celebrate our combined efforts. This is a perfect opportunity to re-charge your 'motivational batteries' to feel refreshed and eager to strive for more headway into the future. Following ARSC2016 we will publish key papers in subsequent Journals. Further details of the Conference are included in this edition.

As always, we welcome comments on the Journal articles and papers. Sharing ideas by working together will help us build the synergy necessary to ensure that all our contributions to reducing road trauma are effective.

*Lauchlan McIntosh AM FACRS
ACRS President*

Global Road Safety: second special issue

Guest Editors, May and August 2016



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Road safety: a pandemic to be tackled on many fronts

"Global Road Safety: Leadership and Delivery" has been the key theme over the two special issues of the Journal of the Australasian College of Road Safety in May and now the August issue 2016. We have had a collection of papers from international organisations playing key roles in providing leadership, management, funding, advocacy, an evidence-base and delivery of road safety globally. We are truly grateful to the many international leaders in the field who have prepared valuable papers for these two issues.

This second special issue again features papers from outstanding road safety activists. A mother, breast cancer survivor and activist, author of *When hope whispers* - provides a personal account of her own journey, Founder and Chairman of The Zoleka Mandela Foundation, an active global road safety advocate - Zoleka Mandela courageously speaks of her tragic and painful loss of her

daughter Zenani just after turning 13 in a drink-driving crash. She calls for urgent sustainable funding and effective action from more road safety activists around the world to protect our children and end deaths and injuries on our roads. Zoleka's call echoes that of her grandfather, the former president of South Africa, the late Nelson Rolihlahla Mandela that our children have the right to 'a life that is free from any violence and fear.'

United Nations Development Programme Goodwill Ambassador, Spokesperson for the FIA High Level Panel for Road Safety, and acclaimed actress with many global hits such as 007's *Tomorrow Never Dies*; *Crouching Tiger Hidden Dragon*; and *Memoirs of a Geisha* - Michelle Yeoh draws on her professional movie career to powerfully expose the harsh and preposterous reality of today's road trauma and the need for road safety activists' constant oversight, committed actions and funding to achieve public interest and measurable results, just as movie makers 'do not leave it to chance that the audience will come flooding through the cinema doors'.

Recognising the scale of deaths and injuries from road crashes worldwide, Bloomberg Philanthropies has been investing \$259M since 2007 with a particular focus on low and middle income countries (LMICs). Bloomberg Philanthropies Initiative for Global Road Safety is funding the world's leading road safety organisations to support national and local governments in LMICs to implement known effective road safety interventions. The paper from Bloomberg Philanthropies provides us a snapshot of the enormous work and resources they are generously committing to road safety, and exemplifies effective private-public partnerships and strategic funding support to deliver road safety in much needed places around the world. Funding support by the FIA Foundation is also reiterated in papers from Zoleka Mandela, Michelle Yeoh, and Global Alliance of NGOs. With 90% of world's road deaths in LMICs, increased investment dedicated to road safety in those countries is even more critical today to drive the number of deaths and injuries down globally. However, high income jurisdictions also have the responsibility to not become complacent about the overall downward trend but maintain focus to drive down the number of deaths and injuries on their roads ultimately to zero.

Nongovernmental organisations (NGOs) also play a key part in generating a demand from the public and from governments for safer roads. Consisting of 170-plus member NGOs active in more than 80 countries, the Global Alliance of NGOs for Road Safety (the Alliance) is a forum where NGOs can share best practices and collectively advocate for road safety and the rights of victims of road crashes. The Director of the Alliance shares the crucial road safety work provided by the Alliance and member NGOs. Consisting of more than 26,000 members from 131 countries, the International Association of Chiefs of Police (IACP) develops road safety awareness programs and resources for law enforcement agencies. The paper from IACP identifies the power and benefits of integrated use of

road safety data, education and enforcement to change road user behaviour.

In line with Vision Zero and Safe System (see paper from Sweden, the first country to adopt Vision Zero in the world) which has been adopted globally as the guiding principle to manage and deliver road safety, we have papers challenging the still non-Safe System road networks worldwide and the enormous opportunities cost-effective engineering treatments and revisions of road design standards could offer to save lives (see paper from international Road Assessment Programme: iRAP, and peer-review paper from leading experts in road safety engineering and design currently working with the Public Works Authority in Qatar), as well as papers demonstrating the application of Safe System in road engineering and speed management (see peer-review papers from Qatar and Canada demonstrating their respective success). We have also included a paper to draw attention to possible ways to align road safety with other key global priorities, specifically climate change, to facilitate the focus on road safety within the global agenda.

Through the collection of wide ranging papers in the two special issues, it is clear that from every different perspective, road safety is a current pandemic, a key global challenge that is in desperate need of urgent funding and resolution. It is clear that many leaders in road safety are committing their time and energy tirelessly to road safety. We hope that these papers assist not only to reassure our work but also to remind us all that we are advocates and agents of delivery on behalf of voiceless victims. We must keep the momentum and the pressure for effective actions and sustained catalytic road safety funding towards zero deaths on our roads worldwide. Everyone has a role to play so that the global road safety challenge is tackled on many fronts - each of us must scale up our own status quo, in the first place to meet the Sustainable Development Goal of halving the number of global deaths and injuries from road crashes by 2020.

Road safety, the movie

Michelle Yeoh



I am in the movie business, and the business of road safety advocacy. What lessons can one offer to the other?

First, a movie doesn't get made unless it catches the imagination. It needs to excite, to inspire, to motivate. It may be a motivation as base as the promise of a blockbuster profit; or it may be a deep emotional reaction

to important art, to a story that simply has to be told. But whichever way it is going to try to reel you in, this movie idea has to be sold in a few short clear sentences, a pitch to hard-nosed financiers that describes both the experience of the popcorn munching punter in the darkened cinema watching the silver screen and the grey-suited accountant in her office watching the bottom line.

Selling road safety operates on exactly the same principles. We can appeal to the human instinct to protect others, we can try to trigger an emotional response based on altruism, pity, self-preservation, or empathy and the realisation that this sudden violent cataclysm can reach out and take away any of our loved ones at any time. We can aim at the cost-counting calculus of long-term returns, the dawning realisation by finance ministers and their officials that, actually, investing in something that reduces both human misery and trauma ward costs is going to save Treasury a lot of money, for marginal outlay. Or, ideally, we can do both.

Imagine, for a moment, that we're in a movie pitch meeting. We (the global road safety activists) walk into a boardroom with a panoramic view of the Hollywood hills. Sitting on the other side of the highly polished walnut table, in deep leather chairs and Tom Ford suits, are the studio bosses. They will decide whether we leave with nothing, or with a shot at the Oscars.

Let's pitch:

"Our movie is 'Terminator' meets 'Contagion'. For years, killer machines have rebelled against their masters and caused a public health catastrophe. They strike indiscriminately, violently. The bodies are piling up, on the scale of a war. Children are not spared, in fact 500 die every day. Our hero has the code that can end the carnage, and must convince world leaders to act. The clock is ticking. Millions of lives are at stake."

(We don't need to imagine the teaser trailer for this movie, because it has already been produced by visionary director Luc Besson. His short, utterly compelling, public service film 'Save Kids Lives' contrasts the journey to school of groups of children in South Africa and France. The visceral scenes on the African highway – and the tragic real-life CCTV footage on which it is based – always elicit shock. I've now viewed Luc's film with many audiences, including

UN Secretary General Ban Ki-moon and His Holiness the Pope. The reaction is always stunned silence, then a deep breath, then an urgently voiced concern that something must be done.)

Back at our pitch meeting, the movie execs have some questions. To them, the story doesn't sound realistic. Why, they ask, has this disaster been allowed to continue for years? If we have the solution to prevent the machines from killing why hasn't it just been deployed? And they aren't so keen on the idea of all these children dying. Including one or two young victims could have dramatic effect, raise the stakes and get the audience onside and rooting for the hero. But 500? Every day? Isn't that just a bit... attritional? By now wouldn't someone have, you know, actually noticed that these kids are disappearing and raised the alarm? Sorry, it stretches credulity too far – something would have been done by now. They're shaking their heads.

So we explain: the machines are clever. They pick people off in ones and twos, spread out across the whole world. Most of the time they're useful and even enjoyable servants, ferrying us around, delivering our goods, getting us from A to B. So we're prepared to look the other way when they do strike, to accept the occasional sacrifice as part of the cost of our mobility. Only occasionally does anyone stop to consider the bigger picture, to look at the way this death over here is connected to that one over there, to aggregate the individual tragedies and to realise the true cost: a hundred thousand dead every month, more than 1.2 million every year. Hospital wards filled with the injured. A hidden, deadly, costly war...

It's a story I've been telling for almost a decade. Travelling the world, for the FIA Foundation, the global Make Roads Safe campaign and, now, for the FIA High Level Panel on Road Safety and the UN Development Programme, I've met road safety campaigners and victims and their families; argued with road engineers; walked the trauma wards with exhausted surgeons; and relayed their messages to government leaders and ministers. Collectively, the road safety community has made great strides since the early 2000's. We've had global ministerial conferences addressed by Presidents; the approval by more than 100 countries of the UN Decade of Action for Road Safety 2011-2020; and we've secured the inclusion of road safety targets in the new UN Sustainable Development Goals (SDGs). The international community is now aware, in a way it wasn't, of the scale of the problem and the need to act.

But recognising something needs to happen and actually making it happen are very different things. We have to keep up the pressure. When we make a movie we don't leave it to chance that the audience will come flooding through the cinema doors. Sure, there are indie sleeper hits, word of mouth successes. But the release of most big movies is managed like a military operation. There'll be news-bites and tit-bits from production during principal photography; the public will be softened up with film trailers and photos on

the internet; a bombardment of features, interviews and talk show appearances with the stars will precede the premiere, supported by an eye-wateringly massive marketing budget that sometimes equals or exceeds actual production cost. And investment in traditional ads is now reinforced with huge attention to social media: recent research shows channels like Facebook, Twitter and Instagram becoming increasingly influential in guiding people to the movies.

The need for constant reinforcement of the road safety message is not lost on those countries with the best performance. Putting in place policies for safer vehicles and roads, and laws governing seat belt and motorcycle helmet use, speed limits and drink driving, is only half the battle. The road user needs to be educated and motivated, and to understand why he is being asked, or told, to behave safely. So effective road safety marketing, supported by consistent enforcement by the police, is vital. But the signals given by our leaders are vital too. In France, in 2002, road traffic casualties fell dramatically, initially not because of new laws or massive investment, but because the country's President, Jacques Chirac, said, publicly and prominently, that the country could no longer tolerate a fatality rate double that of its near neighbour, the UK, and warned that the authorities would be clamping down on bad driving. People listened, and changed their behaviour.

But in many high income countries politicians are complacent. Road deaths are on a long-term downward trend. Unlike our fictional studio bosses, they don't see the urgency of tackling road crashes that – take the USA for example – are killing people in the tens of thousands each year. Yet, as a powerful ad by the Transport Accident Commission in Australia points out, even one death is too many, and how do we choose who is expendable? The TAC went out on the streets of Melbourne and asked the public, 'How many road deaths is an acceptable level?' When put on the spot, it is difficult to justify any answer except: zero. We need to be doing a better job of asking our political leaders the same question, and making them follow the logic of the only possible response.

And in the countries where road traffic deaths are rising fastest the need for political commitment is even greater, even more urgent. As the latest 'global status report' from the World Health Organization shows, it is in middle and low income countries where traffic deaths are rising fastest. In the first few years of the UN Decade of Action for Road Safety, which is intended to be a global effort to stabilise and then reduce the carnage, more than fifty countries saw the number of their citizens being killed on the roads increase. In some African and Asian countries you are at least ten times more likely to die than in Western Europe. The proportion of African children being killed is almost three times that of children in OECD countries, even though motorisation is far lower.

Yet these countries with the highest health burden are the least equipped to deal with the problem. They need help, and the international community needs to provide it. In 2015 the UN Secretary General, Ban Ki-moon, appointed my partner Jean Todt as his Special Envoy for Road Safety, with a remit to challenge the UN system to do more. Too many agencies

still pay lip service to the need for road safety, without deploying budget to deliver action. While influential financial institutions like the World Bank recognise the need to act – the need to ensure, for example, that their road infrastructure loans to countries include consistent safety provisions to avoid adding fuel to the fire – the pace of change is too slow, the most senior decision makers in the hierarchy unengaged. Institutions often blame a lack of demand from their client governments, without making any serious effort to stoke up that demand. A self-perpetuating Catch 22.

I have been involved in advocacy and fundraising for HIV/AIDS, not least through the movie industry's support for the Foundation for AIDS Research, AMFAR. The call to action on HIV/AIDS is constantly amplified by interventions from institutional leaders, OECD government leaders, head of major Foundations, the media and, yes, movie stars and musicians who can capture headlines. This international conversation, this international consensus, provides an enabling environment for action and intervention in countries which need help. Governments in the South recognise the need to act and, when a country slackens the pace or refuses assistance, as with South Africa under President Thabo Mbeki, the international consensus is deafening in its condemnation. This vital feedback loop is utterly lacking for road safety. The denial and inaction on HIV/AIDS that characterised Mbeki's administration is replicated in far too many countries when it comes to road safety. Yet the international community is silent.

So what needs to happen? Now that we have road safety targets in the Sustainable Development Goals (targets negotiated over a three-year period by all the world's governments and endorsed by world leaders) we need to challenge governments to translate them into meaningful and measurable action. We need to work constructively with the international institutions, with donor governments and with the private sector to dramatically increase commitments and action, and not be afraid to call out those who drag their feet. We're advocates on behalf of voiceless victims, and we can't be apologetic about it. We need to engage middle and low income governments and the public in a conversation, and raise the salience of road safety as an issue, as I'm doing at the moment in South East Asia through the 'Safe Steps' campaign. This initiative, supported by the Prudence Foundation and National Geographic Channel, together with the FIA, is using multi-media channels to reach road users with life-saving messages, but also driving home the argument to governments that they have a duty to lead.

To support this effort, we need more funding. There should be 'Safe Steps' type campaigns in every developing country, focusing in on the particular risk factors that are killing people, backed with sufficient financial and communications support to reach large audiences. There should be technical assistance from the World Bank, WHO and others to help kick-start national efforts to get a grip on the crisis. There should be research funding, training programmes, fora for international cooperation, full-time road safety staff in every UN agency. There should be more support for the wonderful work being done on a shoestring by many of the NGOs I have visited.

So I'm proud to be the Spokesperson for the FIA's High Level Panel, which is working to engage major multi-nationals, and government donors, in the effort. In January 2016 we took our message to the World Economic Forum in Davos, the first time the road safety issue has been discussed there. We have high profile CEOs from major companies on board, ready to commit to action and encourage their peers. The establishment of a UN Fund dedicated to road safety was supported by Ban Ki-moon, and agreed by UN member states at the UN General Assembly in New York in April 2016. We can't let this momentum slip.

Back in the Hollywood boardroom, our imaginary movie executives want to give the go-ahead to our project. They've approved the story (with SDG targets), find the script compelling (1.2 million deaths is hard to argue with), and want to see the movie get made. We've assembled an attractive cast and creative team (a Global Plan, clear deliverables, a strong and growing coalition of organisations

working together). But before greenlighting production our moguls need a co-producer. To get our story, our cause, in front of millions of people we need to raise more money and convince more industry insiders. We're halfway to the multiplex, but with a metaphorical mountain still to climb.

Unlike what we see on the cinema screen, the stakes here are all too real. We can make a difference to the lives of billions of people. We can help to prevent millions of deaths and life-changing injuries. If we can make road safety part of the global conversation, if we can persuade governments to act, if we can raise the catalytic funding needed to enable change, if we can influence highway design in Brazil, vehicle standards in India, encourage seat belt wearing in Nigeria and help a child to get to school safely in Indonesia, the rewards will be greater than any Oscars or Golden Globes.

And the way this story ends? That's up to all of us. Lights, camera...Action!

Diary 2016

August 2-5

ICTTP2016: The Sixth International Conference on Traffic and Transport Psychology, Brisbane Convention and Exhibition Centre, Queensland, Australia
<http://icttp2016.com>

August 30- September 1

Fifth International Symposium on Naturalistic Driving Research
 Blacksburg, Virginia USA
<http://www.vtti.vt.edu/NDRS/>

September 6-8

Australasian Road Safety Conference (ARSC2016)
 Canberra, Australian Capital Territory
<http://australasianroadsafetyconference.com.au/>

September 18-21

Safety 2016: 12th World Conference on Injury Prevention and Safety Promotion
 Tampere, Finland
<https://www.thl.fi/en/web/injury-prevention/safety-2016>

October 4-5

Roads between Us: Third Road Safety Conference - Nestlé, Zurich Insurance and the Global Road Safety Partnership
 Kuala Lumpur, Malaysia
<http://www.nrspp.org.au/Events/Details/361>

October 10-14

23rd ITS World Congress
 Melbourne, Victoria
<http://www.itsworldcongress2016.com/>

October 16-19

T2016: 21st International Council on Alcohol, Drugs and Traffic Safety (ICADTS) Conference, Gramado, Brazil
<http://www.t2016.org/>

November 16-18

27th ARRB Conference
 Melbourne, Victoria 3206
<https://www.ivvy.com/event/ARRB16/>

November 24-25

International Conference on Traffic and Transport Engineering
 Belgrade
http://www.ijtte.com/article/102/ICTTE_Belgrade_2016.html

November 28-30

13th International symposium and accompanying exhibition on sophisticated car safety systems, Mannheim, Germany
http://www.ict.fraunhofer.de/content/dam/ict/de/documents/veranstaltungen/2016/Airbag_Call_for_Papers_2016.pdf

November 28 – December 2

Human Factors in Traffic Crashes
 Melbourne, Victoria
http://aspaci.org.au/HumanFactors2016_Flyer.pdf

2017

March 20-23

10th International Conference on Managing Fatigue
 San Diego
<http://fatigueconference2017.com/>

Head Office News

Welcome to new Bronze Corporate members

Accident Compensation Corporation, Wellington, New Zealand
CSP Pacific, Auckland, New Zealand

Chapter reports

Queensland Chapter Report

January – June 2016

The Queensland Chapter held its AGM and Chapter meeting on 7 June 2016. The seminar preceding the AGM was presented by Amy Schramm. Ms Amy Schramm is a Senior Research Officer with seven years of experience at CARRS-Q. She has worked on a number of large projects in the area of cyclist safety and has completed several cycling projects that have arisen from the Transport,

Housing and Local Government Committee Inquiry into Cycling Issues. She is an experienced road safety researcher who has published nationally and internationally on a range of road safety topics including vulnerable road users, intelligent transport systems, and older drivers.

The presentation was titled “Evaluation of the Queensland minimum passing distance road rule”. Earlier this year, CARRS-Q completed an evaluation of the minimum passing distance rule for cyclists that received considerable media attention. The presentation gave a summary of the findings regarding the practical implementation of the road rule, the impact of the road rule on road user attitudes and perceptions, and the road safety benefits.



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Annual General Meeting

The Executive for the Qld Chapter duly elected at the AGM are: Chair – Dr Mark King, Deputy Chair Dr Kerry Armstrong, Secretary/Treasurer Ms Veronica Baldwin. Committee members – Professor Narelle Haworth, Mr Joel Tucker, Ms Claire Irvine, Dr Jason Edwards, Mr Simon Kirkpatrick

*Information prepared by Veronica Baldwin
Secretary/Treasurer, Queensland Chapter*

ACT and Region Chapter

The ACT & Region Chapter held its Annual General Meeting during the Quarter. The main officer bearers re-elected were: Eric Chalmers, Chair and representative to the National Committee; Steve Lake as Treasurer; and Keith Wheatley as Secretary.

The Chapter continues to work with the 2016 Australasian Road Safety Conference team on local aspects of its management and individual members are more directly involved in the team.

The Chapter has been commissioned by the ACT Justice and Community Safety Directorate to develop and manage the 2016 Road Safety Forum - Drug Driving; which involves JACS and ACT Health. The Forum will be held as an afternoon/evening event to encourage interested parties to attend. The keynote speakers will be Professor Kim Wolff MBE, from Kings College, London, who will make her presentation via video link. Professor Wolff was Chair of the UK Panel on driving under the influence of drugs, which reported to the UK Government in 2013. The report was the primary document on which the revised British drug driving laws were based.

Also speaking will be Professor Jeremy Davey, from CARRS Q who will outline the development of drug driving programs in Australia and look into the possibilities for improving the programs in Australia.

It is expected that around 40 people with direct interest in the subject from the ACT and Region will attend. ACT Road Safety Minister, Shane Rattenbury, will host the Forum and lead the discussions.

The Chapter is now receiving a steady flow of requests to host and manage seminars and forums on specific issues. The next is likely to be on the interaction between heavy vehicles and buses with vulnerable road users. This trend provides positive feedback that the Chapter's work in supporting the region's road safety stakeholders to come together to address practical aspects of road safety issues is seen as both worthwhile and a positive contributor to road safety.

WA Chapter Road Safety Forum

The Western Australian Chapter presented a road safety forum at the Technology Park Function Centre on 4 July with presentations by Paul Roberts and Professor Michael Regan. A buffet style lunch was provided.

The first presentation was an ***“Outline of road safety research projects with the CMARC-ARRB driving simulator”*** by Dr Paul Roberts, Principal Behavioural Scientist, Behavioural Science, ARRB

Paul joined the Western Australian office of ARRB Group Ltd in 2004. He has a PhD from the University of Western Australia. Paul has a particular interest and expertise in the way in which cognitive factors such as fatigue and distraction impact on driver behaviour and road safety generally.

He has researched and consulted on numerous road safety projects including a major study of seatbelt usage for the Western Australian Office of Road Safety, a study of fatigue countermeasures for Land Transport New Zealand and for Austroads, a statistical analysis of crash rate reductions associated with road engineering countermeasures for Austroads and the Australian Road Assessment Programme star rating studies. He has regularly worked in the mining sector. Recent projects include a fatigue audit of an Indonesian mine, an assessment of options for reducing the risk of traffic incidents, a study of level crossing safety systems in remote locations and an assessment of light vehicle safety issues in a mining context.

The second presentation was titled ***“Using driving simulators to understand human factors in road safety research”*** by Professor Michael Regan, Chief Scientist, Behavioural Science, ARRB

Professor Mike Regan joined ARRB Group in January 2015. Prior to that he was a Professor in the Transport and Road Safety Research (TARS) group in the School of Aviation at the University of New South Wales. Currently, he holds an honorary appointment as Adjunct Professor with the School of Aviation. Mike has BSc (Hons) and PhD degrees in experimental psychology and human factors from the Australian National University and more than 20 years' experience as a transportation safety specialist – as a researcher, research manager and policy maker.

Mike has specialist expertise in experimental psychology, human factors and ergonomics, and is a recognised world authority on driver distraction and inattention, driver interaction with intelligent transport systems, field operational testing of advanced driver assistance systems and human-in-the-loop simulation. He has designed and led more than 100 major research projects in transport safety – spanning motorcycles, cars, trucks, buses, trains and aircraft – on topics including driver distraction and inattention; driver interaction with intelligent transport systems; driver and pilot selection and training; human error in road and aviation crash causation; vehicle and roadway human-machine interface design; and driver licensing. He is the author/co-author of many published

papers and continues to develop, significant international collaborations with leading transportation safety research institutes and individuals around the world.

The event was supported by Curtin University, ARRB and the Australasian College of Road Safety.

The presentation provided a fantastic opportunity to

discover the story behind the newly opened C-MARC/ARRB driving simulator at Curtin-Monash Accident Research Centre (C-MARC), with the first 20 registered attendees having the chance to see inside of the C-MARC/ARRB driving simulator.

Victorian Chapter Report

The Victorian Chapter jointly held a seminar with the Institute for Transport Engineers (ITE) in May 2016. The ACRS seminar was on the Decade of Action for Road Safety: A global perspective on road safety, and included four speakers who have travelled overseas to learn about different aspects of road safety. The presentations focussed on what the speakers have learned from their experience, and how they have implemented, or would like to implement, what they have learned. The ITE seminar involved speakers sharing their experiences about working in Asia, including seeking and winning work, cultural change and challenge, technical trends and emerging opportunities, project delivery, and knowledge sharing.

Jointly running the seminars with ITE had a positive impact on registration numbers, with approximately 80 people attending.

The Victorian Chapter also made a submission to the Parliamentary Inquiry into Lowering the Probationary Driving Age to 17 Years. Our submission does not support lowering the licensing age to 17, as the evidence shows that this will increase road trauma. The submission is publicly available on the Victorian Parliament's website: <http://www.parliament.vic.gov.au/lrrcsc/article/2959>

Melinda Spiteri
Victorian Chapter Chair

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- Building capacity for road safety and **taking responsibility**
- Gruen Transfer: **The Road Safety Pitch** - A fresh lens on road safety
- Supporting organisations to encourage **safe mobile phone use by workers** whilst driving
- Embracing safety – **Road safe: Worker safe**
- Safe System transformation for **pedestrians**
- Driver licensing for **Aboriginal and Torres Strait Islander people:** Challenges and opportunities
- Road safety's **Family Feud**
- The MUARC-TAC Enhanced **Crash Investigation Study:**
Early findings from the case and control data
- Applying Australia's approach to road safety in **Low and Middle-Income Countries**



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Peer Review Papers

Qatar's school safety program: applying Safe System principles

by Fabian Marsh¹, Michael De Roos² and Richard Webster³

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Abstract

Children's safety is a priority outside schools where there is often a mix of vulnerable road users and high numbers of vehicles. This paper outlines some of the issues presented by schools in Qatar and provides an overview of how the Safe System approach has been incorporated into school zone improvements.

Protecting children, who by their nature are unpredictable and impulsive, around schools has always been a sensitive safety issue. It is a key Safe System principle that the road user is not blamed for the crash and that other measures are developed to manage safety. Likewise, it is unrealistic to rely on motorist's willingness to comply with speed limits in order to create a safe speed environment.

Across the globe school zone programs have reasoned that any reduction in vehicle travel speed is evidence of success. This argument does not align with Safe System principles and more is required. The Qatar experience is proposed as a Safe System model for developing and implementing Safe School Zones.

Keywords

Safe System, School zone, Speed, Self-enforcing

Introduction

The protection of children travelling to and from school is a highly emotional issue that has challenged road safety professionals across the globe for decades. Speeding in school zones is of particular concern given the high levels of vulnerable road user activity. The most common measure to reduce vehicle speeds is to introduce a dedicated school zone speed limit which is lower than the prevailing speed limit. School zone speed limits typically range from 24 km/h (15 mph) to 40 km/h (25 mph) (Fitzpatrick, 2009). A reduced speed limit is typically implemented via a timed,

or temporary, restriction based on periods of peak school related traffic activity.

Supplementary devices such as high-visibility signs, flashing lights, electronic speed feedback signs and enhanced road markings such as coloured speed numerals, zig-zag lines and dragon's teeth markings have all been used, with varying effect, in an effort to achieve compliance with school zone speed limits. Despite efforts aimed at reducing speeding in school zones, speeding still remains very common (Ellison, 2011). Concerns regarding compliance have naturally led to greater levels of enforcement including fixed speed cameras. However, while speed enforcement strategies are proven to be effective, reducing speeding by 71% in New South Wales (Road Safety Council Position Paper), they can be highly unpopular and risk negatively impacting the credibility of the school zone safety program (Courier Mail, 2014).

This paper proposes a method of improving school zone safety that is demonstrably safe, popular with school communities, improves traffic management, increases parking provision and does not require enforcement of the speed limit. First, the literature on speeding in school zones is reviewed, followed by an overview of the methodology. The most important results are presented and the paper concludes with a discussion of the results and policy considerations.

Literature review

Ellison (2011) includes a comprehensive literature review that considers many of the recently published papers, and notes that speeding through school zones is common. The suggestion is made that engineering the environment may be more effective than relying on measures to affect driver behaviour.

Over the years there have been numerous attempts to improve the compliance with school zones however, most have relied on measures that seek to affect driver

choice of speed. The state of New South Wales manages temporary speed limits of 40 km/h applied in school zones on weekdays from 08:00 to 09:30 and from 14:30 to 16:00 during school terms (Ellison, 2011) and continues to implement initiatives designed to further enhance the school zone. In addition to the high-visibility fluorescent signs and yellow and black 40 pavement patches, the Minister for Roads announced in 2006 a major package of initiatives to improve safety of school zones: flashing lights, speed cameras, increased fines and demerit points and volunteer marshals (to accompany children to the school gate) which allowed drivers to stay in their vehicle. In addition, he announced a round table to further improve safety and a plan to recruit additional school crossing supervisors (New South Wales Government, 2006). A further initiative utilising road marking known as Dragon's Teeth (or longitudinal triangular road markings) was implemented in 2009 to again enhance the school zone to drivers in New South Wales (Roads and Traffic Authority, 2009).

However, the measures that are most often used to improve safety around schools, such as part-time speed limits, warning signs, and flashing lights have limited effect on driver compliance (Ellison, 2011; Radalj, 2002; Roper et al., 2006; Fitzpatrick, 2009).

Graham and Sparkes (2010) found that in addition to a reduction in child pedestrian crashes (46%) there was also a reduction in other pedestrian crashes (45%), of all vehicles crashes (35%) and a reduction of speed related crashes (20%) in school zones during school zone times. This result can also be understood as the expected benefit of reducing travelling speed and demonstrates that the benefits of school zones can be applied more broadly.

Flashing lights have been found to have a positive effect on travel speed. However, it is significant to note that these evaluations show a reduction in mean speeds ranging from 1.65 to 2.65 km/h (Radj, 2004) with the greatest effect attributed to vehicles travelling at very high speeds (Saibel, 1999). This suggests that drivers travelling at very high speeds moderate their speed but are still exceeding the speed limit through the school zone.

It has been argued that small reductions in mean speeds can deliver good safety benefits, which can be predicted using the Power Model. This is positive but still not in accordance with the Safe System and survivability threshold speeds. Arguably a model that delivers consistent safe speed through a school zone will deliver even greater road safety benefits.

Qatar School Safety Program

The State of Qatar is a peninsula located on the north east coast of the Arabian Peninsula, with a total land area of approximately 11,500 square kilometers. The population is approximately 2.5 million (QMDPS, 2016) with more than 80% of inhabitants residing in Doha. The State of Qatar has experienced rapid economic growth over the last several years, which has resulted in an increased demand for the

State to construct and provide first-class road and transport infrastructure.

Growing concern about the level of road trauma led to the development of Qatar's National Road Safety Strategy (2013-2022), which was launched in January 2013 (QNRSS, 2013). The strategy has adopted the Safe System, an ambitious vision to reduce road trauma, and included a commitment to improve safety outside schools.

School zones in Qatar often comprise multiple educational facilities clustered together in the same area. Travel patterns vary greatly with schools serviced by fleets of buses, students driving themselves to school, students being dropped-off by parents or carers, or any combination of the above. In addition, trips associated with schools are often distributed across the city. This creates high traffic demand on the road network surrounding the schools, particularly where schools are located close to major roads. Vulnerable road user activity is generally confined to the immediate vicinity of schools during the hot summer months.

Safety conditions outside schools had been of concern for some time. The fast pace of infrastructure development in Qatar has led to a legacy of schools serviced by incomplete or undeveloped road networks. This means that there is often a lack of formal road space allocation and a lack of provision for parking and pedestrian activity.

It was necessary to develop a school safety program that:

- (a) Provides a safe environment for vulnerable road users;
- (b) Efficiently manages the very high traffic peak;
- (c) Provides for parking of cars and buses;
- (d) Includes safe and convenient pedestrian crossing facilities; and
- (e) Discourages parking on footways.

The program needed to be relatively simple to apply and based on proven road safety and traffic management principles, while being sufficiently flexible to accommodate the needs of individual schools. Delivering the school safety program involved several steps: 1) writing a school zone guide; 2) installing and monitoring school zones; and 3) evaluating the performance of school zones.

School zone guide

The school zone guide was developed based on a number of assumptions and guiding principles:

- (a) A speed limit of 30 km/h was adopted based on pedestrian impact survivability threshold levels. Where motorised traffic mixes with pedestrians and cyclists, the speed limit must not exceed 30 km/h (WHO, 2015). This is due to the vulnerability of these road users at increasing speed: human biomechanical injury tolerance for a pedestrian hit by a car will be exceeded if

the vehicle is travelling at more than 30 km/h (Johansson, 2009);

- (b) The speed limit needed to be applied full-time, not part-time. Schools can be pedestrian generators outside of school zone times and children can be hit at any time of the day. It was also observed that many school premises are used for a range of purposes in the evenings and on weekends. Full-time speed limits avoid the problems associated with informing drivers when the reduced speed limit applies. In addition, research has shown a substantial benefit to all road users when reduced school zone speed limits apply (Graham and Sparkes, 2010);
- (c) The school zone was to be self-enforcing. The combination of traffic calming measures was to be implemented in such a way as to create a zone that naturally reduced driver's speeds without the need for enforcement (Fildes and Lee, 1993). Further, traffic-calming devices were to be placed at regular intervals to ensure desired speed profiles throughout the school zone were achieved (Austroads, 2008);
- (d) All marked (zebra) pedestrian crossings were to be on a raised platform. Research shows that a raised pedestrian crossing is safer than an at-grade crossing (Austroads, 2012). A raised crossing also serves as a traffic calming measure to slow vehicles;
- (e) To keep the process simple, the application of various engineering measures and facilities was not limited by traditional design warrants; such as a pedestrian demand warrant for a particular crossing type. Instead, the type and placement of traffic calming measures were to be implemented based on engineering principles supported by consultation with the school community.

The Guide was written based on Safe System principles and includes a toolkit of devices for the designer to select from, a guide for the project manager or designer to consult with the school community and a checklist for the designer to ensure all relevant design elements were addressed. The Guide also required preparation of supplementary standard drawings and approval of new products such as:

- (a) High visibility signs: a new sign was designed with a fluorescent yellow backing board which incorporated a supplementary plate with the word 'school' in Arabic and English. The sign at the end of the school zone has the same design with a single thick diagonal line, indicating end. The fluorescent yellow colour was used as a 'theme' and repeated on pedestrian sign backing boards and reflective bands on bollards;



Figure 1. Example school zone signs and bollards

- (b) Drop-and-ride facility: there was a need for a facility at many schools that allowed cars to stop and let children out near the school gates. A design was prepared for a drop-and-ride facility that was wide enough to enable a vehicle to pass another stopped vehicle. Drop-and-ride facilities are typically installed as close to the main gate as possible;
- (c) Raised pedestrian crossing: it was necessary to prepare a standard drawing for a pedestrian crossing on a speed table together with associated signage. All pedestrian crossings under the school safety program are installed on raised platforms/tables;
- (d) Bollards: due to the problems associated with vehicles parking on the footway outside schools it was necessary to identify a suitable bollard that was also passively safe. The European specification EN12767 was adopted as the basis for selecting suitable school zone bollard systems;

The preferred position for schools adjacent to high-speed multi-lane roads was to deny access from the high-speed road and to provide safe and convenient access from adjacent suburban roads. On some high-speed roads there was sufficient space to provide a service road, which would receive the full school zone treatment depending on consultation with the school. Lengths of pedestrian fencing were installed to separate pedestrians from fast moving traffic.

Installation and monitoring

The installation of traffic calming measures to create a self-enforcing, 24-hour, 30km/h speed environment was central to the school zone concept. Standard school zone signs were used in combination with a gateway treatment to reinforce the limits of the school zone and the lower speed environment. Gateways typically incorporate narrowing of the carriageway with central islands. In some locations, gateways are combined with speed humps or raised pedestrian crossings. A typical 30 km/h school zone gateway treatment is shown in Figure 2.



Figure 2. School zone gateway treatment at London School

Where the right-of-way width is sufficient, a central median is typically installed to smooth traffic flow and to prevent undesirable turning and U-turn manoeuvres. This also has a calming effect on vehicle speeds. Other measures to reduce vehicle speeds within the school zone include speed humps, speed tables and raised pedestrian crossings. All formal pedestrian crossings within a school zone are provided on a raised speed table. Safety is further enhanced for pedestrians with fencing to direct pedestrians to formal crossing locations and bollards to prevent vehicles from parking on footpaths. A typical treatment within a school zone including a raised pedestrian crossing, a central

median, pedestrian fencing, bollards, angle parking and a pick-up/drop-off facility is shown in Figure 3.



Figure 3. Treatment within Middle East International School zone

Pedestrians are a priority in the school zone. Where possible, footways are at least 2.5m wide and provided on both sides of the road. Safe and convenient pedestrian crossings are installed on pedestrian desire lines. Pedestrian fencing can be selectively used to support the pedestrian facilities. Based on the individual needs of the school, drop-and-ride facilities are provided adjacent to school entry points and parking is maximised through provision of

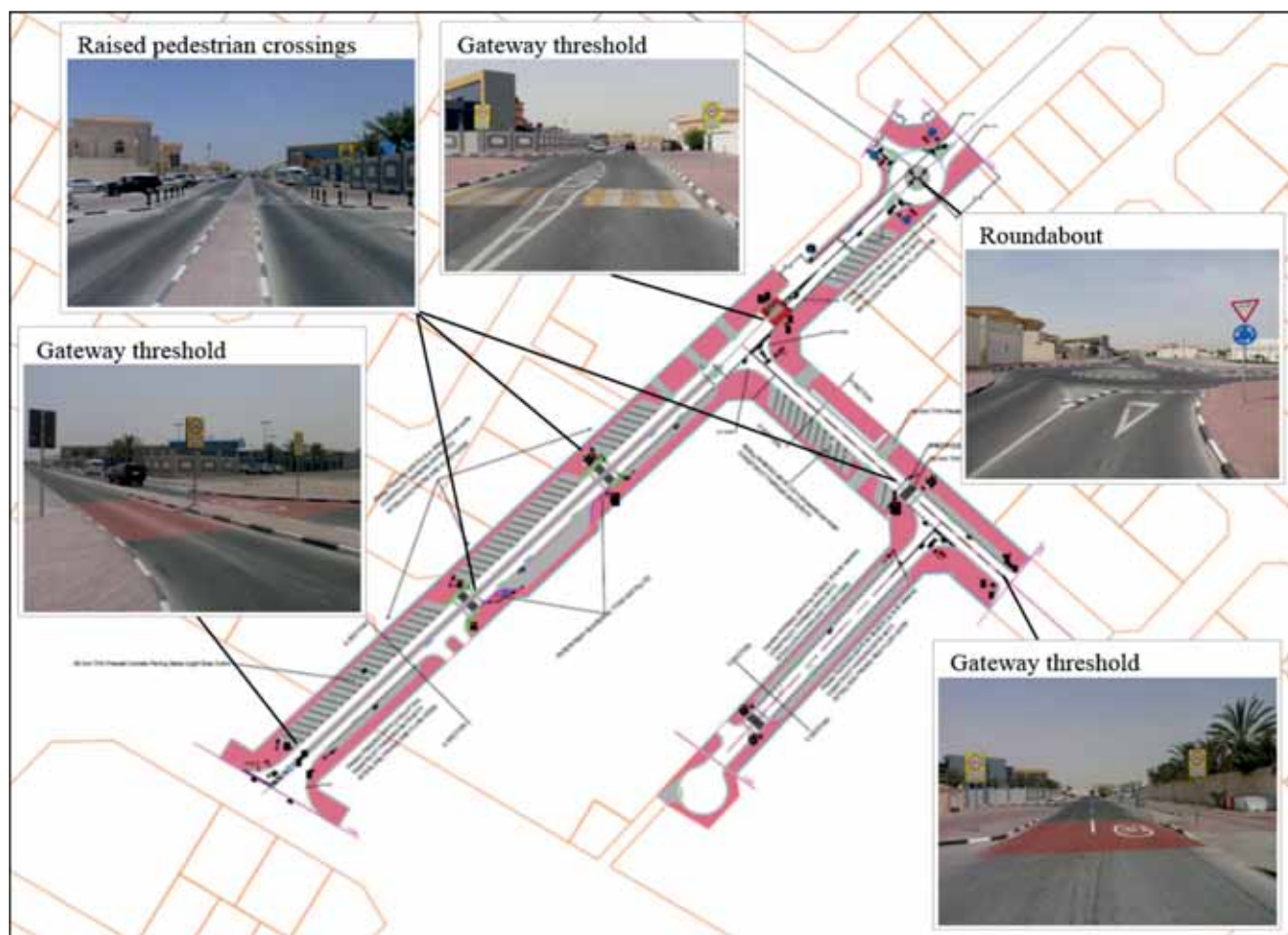


Figure 4. Typical school zone layout (Middle East International School)

angle parking wherever possible. Where there is insufficient width, roads have been converted to one-way operation. Raised central medians are installed in all designs where there is space in order to manage ad-hoc turning movements and to improve pedestrian safety (Bowman, 1993). Raised central medians are also very useful in managing traffic peaks. Roundabouts are used whenever there is a raised median to provide for connectivity while providing the added benefits of managing traffic speed and improving pedestrian safety (Harwood, 2008).

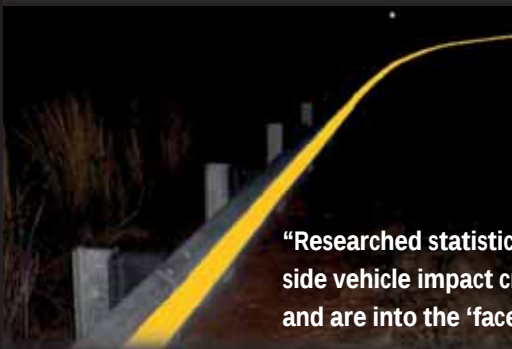
A typical school zone layout is shown in Figure 4.

As the first school zones were installed they were closely monitored to check whether the pedestrian facilities were being used, that vehicle speeds had been reduced to safe levels, and that traffic flow and operation had improved. Some of the observations included:

- The pedestrian facilities were generally being used correctly. This was a pleasing outcome as previously there were no pedestrian crossings. However, where people were not using the designated crossings they were still in a safer environment due to the reduced vehicle speeds and, where installed, the presence of raised medians;
- Pedestrian facilities were most effective when used in combination with pedestrian fencing;

- It was noted that traffic-calming devices were more effective in reducing speeds when placed at about 80 metre intervals;
- Central medians have proven effective in stopping ad-hoc turning movements and U-Turn manoeuvres;
- Roundabouts have been successful in calming traffic and accommodating U-Turn manoeuvres;
- Bollards were successful in preventing vehicles from parking on the footway. However, it was noted early in the program that long lengths of bollards installed at 1.5 metre intervals were excessive and future installations used bollards more selectively and in combination with pedestrian fencing.

While traffic flow has improved, the high demands placed on the road network due to the concentration of multiple schools and high student numbers means that congestion is still experienced, though to a lesser extent, at some clusters of schools. There has been pleasing support from school communities with numerous requests for similar school zones. Several letters of appreciation have been received from school principals including recognition of the consultation that has been undertaken. Overall, the engineering of the road layout, pedestrian facilities, parking, pick-up/drop-off areas, etc., has significantly improved safety while managing traffic flow and operation around schools.



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Evaluation

Speed surveys were undertaken to evaluate the impact of Qatar's school zones on driver speed behaviour. The surveys were designed to capture vehicle speed data after school zones were implemented to assess the effectiveness of speed reduction upon entry and throughout the school zone. The objectives of the surveys were, firstly, to determine whether the school zones had successfully reduced vehicle speeds to 30 km/h and, secondly, whether reduced speeds were maintained throughout the entire day, i.e. over 24-hours.

The sample consisted of 23 survey sites at eight school zones within the city of Doha. All of the schools included in the evaluation were located on single carriageway local roads. Surveys were undertaken on approach to the school zone, at the school zone entry gateway point, approximately midway between the entry gateway and the first raised pedestrian crossing or speed hump, at various locations fully within the school zone and approximately midway between the last raised pedestrian crossing or speed hump and the exit gateway.

Surveys on approach to the school zone were undertaken at three schools approximately 100 metres before the school zone entry gateway. Whilst there was no formal posted speed limit on the approach roads, each was considered typical of a 50 km/h or 60 km/h local residential road. Gateways at the other five schools coincided with intersections, either with boundary roads or with

roundabouts that were installed as a speed management measure. The separation distance between each gateway and first or last raised pedestrian crossing or speed hump ranged from 55 metres to 110 metres, with an average of 80 metres. The separation distance between raised pedestrian crossings and speed humps within each school zone ranged from 65 metres to 170 metres, with an average of 90 metres.

All surveys were undertaken over a period of one week including the weekend except for the International School of London and Middle East International School. The survey period for these two schools was 24-hours. All speed surveys were undertaken using MetroCount pneumatic tube counters.

Results

To evaluate the school zones, only recorded vehicle speeds of 10 km/h or more were included in the analysis. Vehicle speeds of less than 10 km/h were assumed to be indicative of congestion or dropping off or picking up children within the school zones.

The speed surveys undertaken at 23 sites throughout the eight school zones resulted in 527780 vehicle records that satisfied the set criteria of travelling 10 km/h or more. This assessment adopts a different approach to most research on school zones in that it does not specifically evaluate vehicle speeds during school peak time periods. Rather, to evaluate the first hypothesis, i.e. that Qatar's school zones are effective in reducing vehicle speeds to 30km/h, 85th percentile speed data was extracted in both directions (two-

Table 1. Survey site numbers for each school by description of site location

School	Site survey number and distance between measures				
	Before School Zone (1)	At gateway (2)	Between gateway & crossing (3)	Middle of School Zone (4)	Between crossing & gateway (5)
International School of London ^a	1 (100m)	2 (20m)	-	3 (65m)	-
Aatika Primary School	1 (90m)	-	2 (55m)	-	3 (60m)
Middle East International School ^{a, b}	-	-	-	2 (90m) & 3 (70m)	1 (55m)
Al Falah Independent Primary School ^b	-	-	-	1 (85m) & 2 (170m)	-
Tarik Bin Zayid Secondary School	1 (100m)	-	2 (80m)	3 (70m) & 4 (60m)	-
Khalifa Secondary School ^b	-	-	-	1 (95m)	2 (95m)
Park House English School ^b	-	-	3 (110m)	1 (110m) & 2 (60m)	-
Madinat Khalifa North School ^b	-	-	1 (95m)	2 (85m) & 3 (90m)	-
Total sites	3	1	4	12	3

^a 24-hour survey

^b Gateways at intersections

way) over a 24-hour period at all recorded locations on approach to and throughout each school zone. This data was then aggregated across all of the school zones to determine a “typical” 24-hour, two-way, 85th percentile speed profile as vehicles approach and pass through a “generic” school zone. Speed results for the first hypothesis are presented in Table 2 and Figure 5.

While the aggregated results indicate a negligible speed

reduction at the school zone gateway treatment, closer inspection of the individual results for the International School of London reveals a substantial drop in speed. The 85th percentile speed on approach to the school zone drops from 66.2 km/h to 51.5 km/h at the gateway, representing a reduction of 14.7 km/h. This effect is not prominent in the aggregated results because the higher approach speed for International School of London is offset by the significantly lower 24-hour survey sample size.

Table 2. 85th percentile speed survey results (24-hour, two-way)

School	85th percentile speed (km/h) and sample size (n)				
	Before School Zone (1)	At gateway (2)	Between gateway & crossing (3)	Middle of School Zone (4)	Between crossing & gateway (5)
International School of London ^a	66.2 (4224)	51.5 (4215)		33.1 (4098)	-
Aatika Primary School	43.9 (35769)	-	33.8 (33136)	-	33.5 (31772)
Middle East International School ^{a, b}	-	-	-	34.9 (18657)	31.3 (9345)
Al Falah Independent Primary School ^b	-	-	-	36.4 (11797)	-
Tarik Bin Zayid Secondary School	54.7 (36449)	-	33.5 (24982)	32.0 (36513)	-
Khalifa Secondary School ^b	-	-	-	38.5 (19874)	31.0 (19098)
Park House English School ^b	-	-	33.5 (26407)	32.8 (40574)	-
Madinat Khalifa North School ^b	-	-	39.2 (67158)	37.4 (103712)	-
Aggregated Results	52.2	51.5	37.1	35.8	32.4

^a 24-hour survey

^b Gateways at intersections

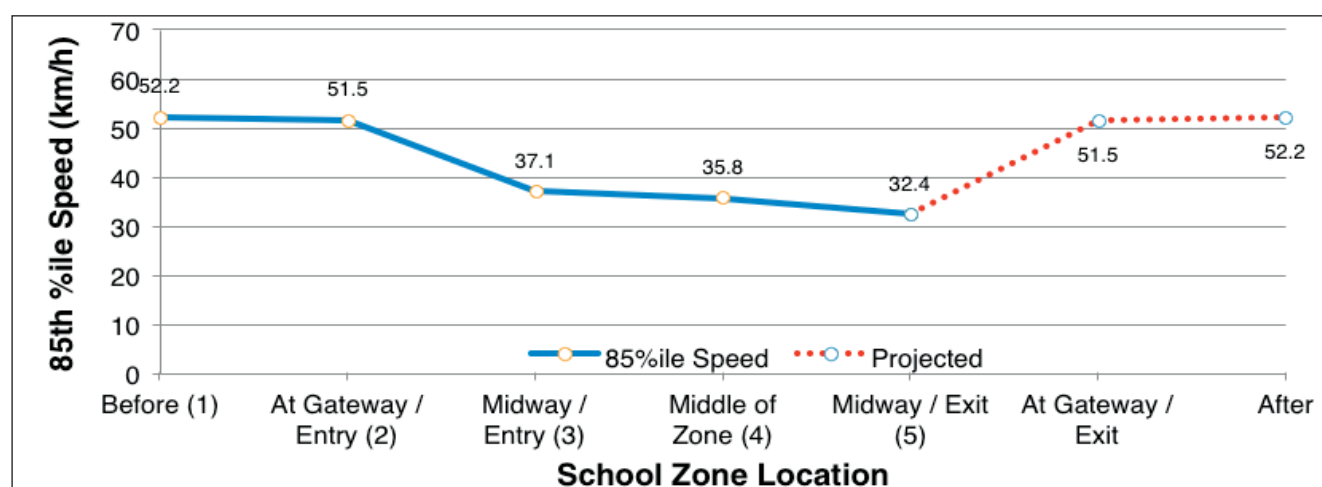


Figure 5. 85th percentile speed profile as vehicles approach and travel through school zones

The results show that speeds are significantly lowered once vehicles enter the school zone. The “transition” length, i.e. the distance between the entry or exit gateway and the nearest traffic calming device, which is typically a raised pedestrian crossing, averages around 80 metres. The length within the school zone, i.e. between locations (3) and (5), represents the area of greatest school related activity. Within this area, the 85th percentile speed is reduced by between 15.1 km/h and 19.8 km/h. This represents a substantial reduction in vehicle speeds, which would translate to significant reductions in fatal and serious crash risk (Nilsson, 2004).

The longitudinal speed profile demonstrates the effectiveness of the school zone treatment. The results indicate that vehicle speeds recorded within the school zone are consistent with Safe System 30km/h levels.

To test the second hypothesis, i.e. that Qatar’s school zones are self-enforcing and that lowered vehicle speeds are maintained throughout the entire day, 85th percentile speed data was extracted in both directions (two-way) and compiled into 24-hour speed profiles at the same locations: before the school zone, at the gateway, mid-way in the school zone and in the middle of the school zone (Appendix A).

The aggregated 24-hour speed profiles on approach to the school zone and at the school zone gateway are shown (in Appendix) in Figures A1 and A2, respectively. The approach profile shows a reasonably consistent 85th percentile speed that fluctuates from around 50 to 58 km/h. This is considered typical of a 50 km/h local residential road, though it is notable that the approach speeds for individual schools indicate some variation, with International School of London indicating an 85th percentile speed more typical of a 60 km/h local residential road. The gateway profile shows the greatest variation, which may be attributed to the fact that gateways will typically have less traffic calming effect than the measures further into the school zone, and that the sample size is substantially lower than the other profiles.

Profiles for the speed surveys conducted within the school zone (Figures A3, A4 and A5) show clearly that vehicle speeds are maintained at lower Safe System 30km/h levels at all times of the day. The evidence suggests that this will deliver a substantial road safety benefit to all users at all times (Graham and Sparkes, 2010).

Conclusions

The Qatar school zone program demonstrates that there is a better model for designing and implementing school zones. By applying sound traffic engineering principles, it is possible to install school zones that manage vehicles speeds to safe levels while managing high traffic volumes. The school zone program does not need to have complications associated with temporary speed limits, or require additional supplementary measures such as flashing lights. It is simpler and safer for all road users to apply a full time speed zone supported by traffic calming measures.

The Qatar program relies heavily on input from school communities who have welcomed the initiative. The Qatar program also demonstrates that it is not necessary to rely on enforcement within the school zone. Enforcement is highly unpopular in school zones and complex when based on time of day and whether it is a school day. The simpler and much more effective solution is to have an engineered self-enforcing road environment. As Fildes and Lee (1993) have suggested, self-enforcing traffic calmed areas can also have a positive benefit-cost-ratio for all road users.

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APPENDIX

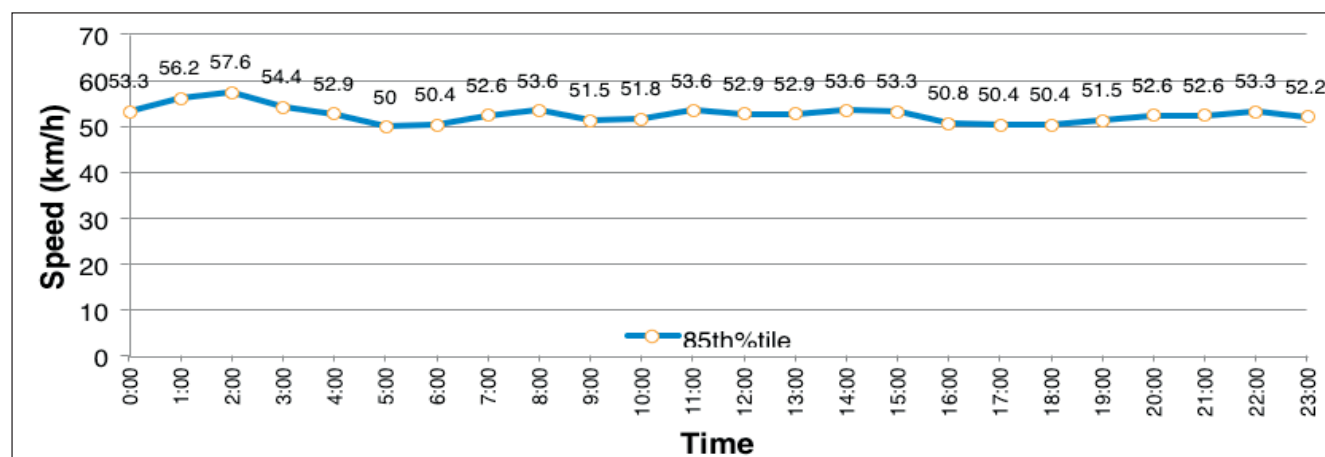


Figure A1. Before school zone (aggregated 24-hour two-way profile)

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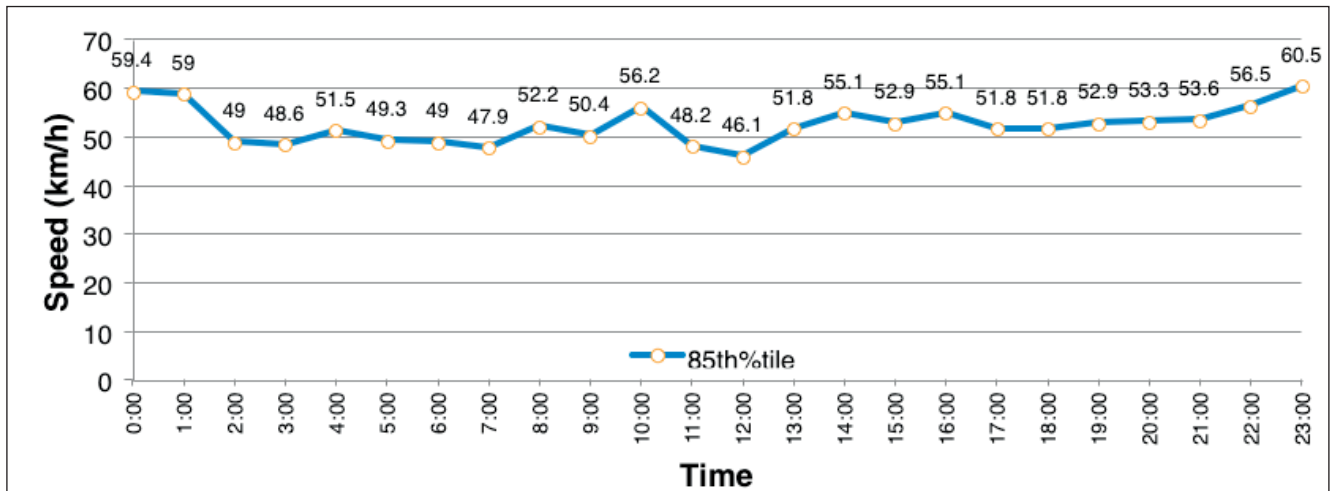


Figure A2. At gateway (aggregated 24-hour two-way profile)

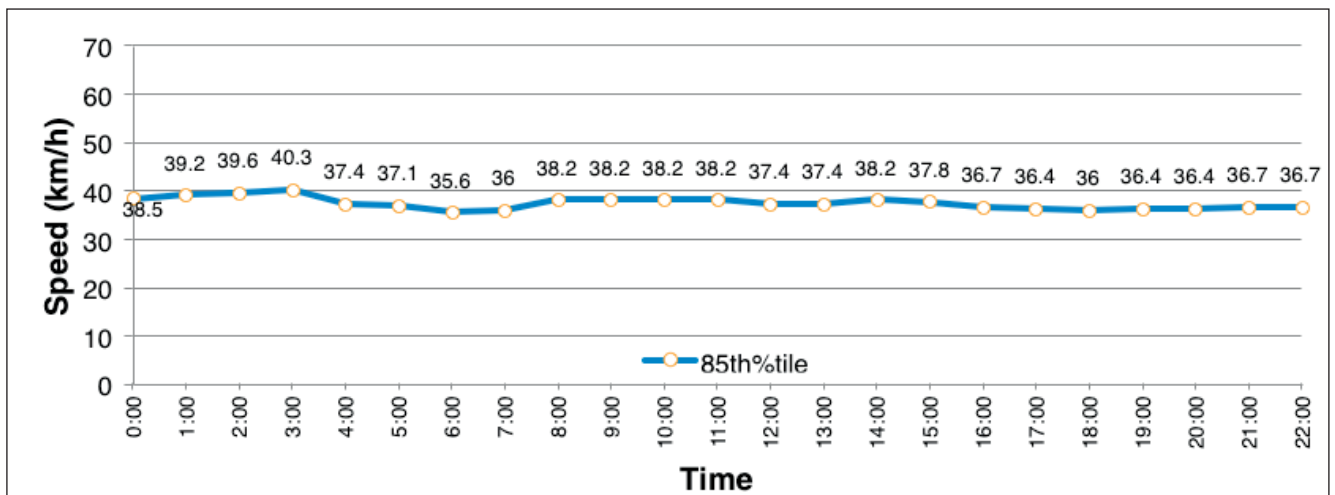


Figure A3. Between gateway & first crossing (aggregated 24-hour two-way profile)

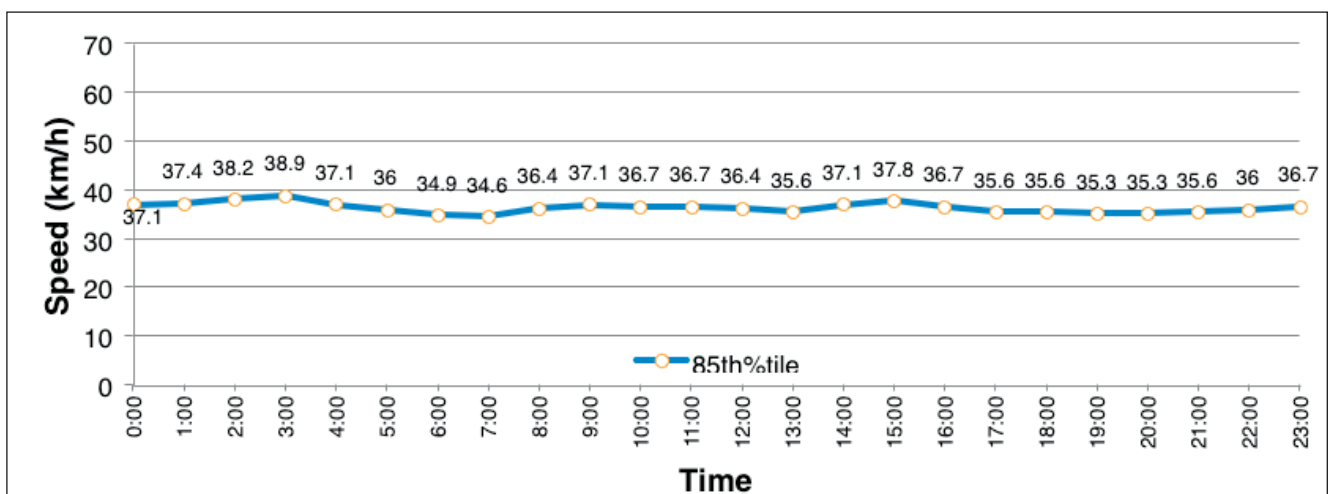


Figure A4. Middle of school zone (aggregated 24-hour 2-way profile)

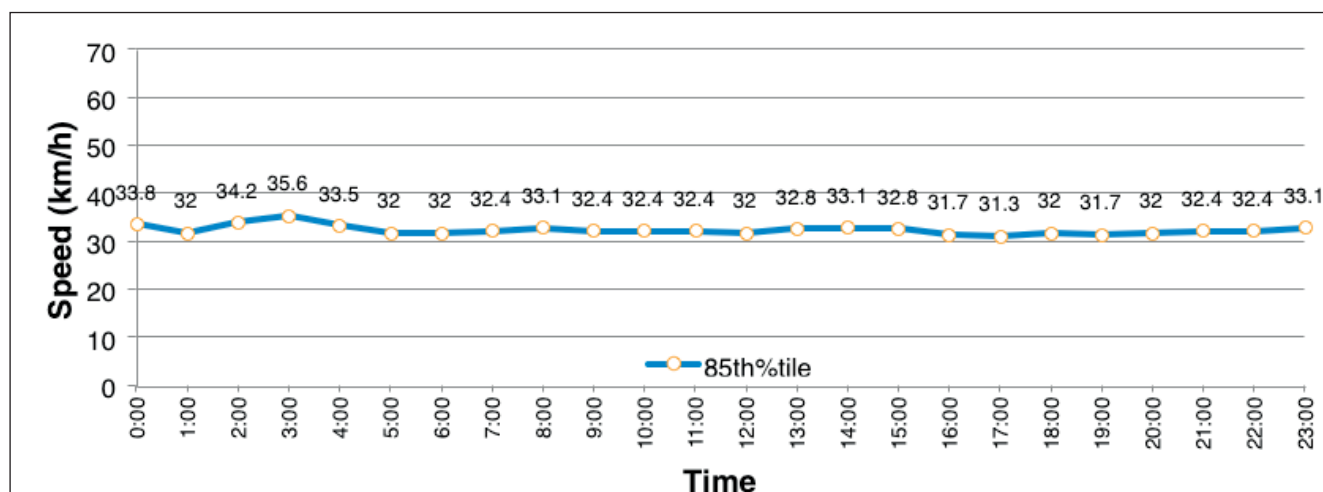


Figure A5. Between last crossing & gateway (aggregated 24-hour 2-way profile)

Canadian Legislation on excessive speeding: successful intervention through penalty increases

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Abstract

Excessive speeding is a global problem experienced on roads all around the world. The impacts of this behaviour on the safety of all road users have led many jurisdictions to adopt more significant sanctions when dealing with such offenders. This paper assesses the impacts of adopting more significant sanctions against excessive speeders in Canada while also considering issues which should be explored when adopting such a policy. The paper uses ARIMA intervention analysis to assess changes in fatal collision data since the adoption of stronger penalties. The changes were assessed for statistical significance, and the magnitude of the change was quantified. In general, the findings show that the legislative changes allowing for stronger penalties were associated with significant drops in province-wide fatal collisions. Reductions in the mean level of monthly collisions ranged from 5% to 22% at the three provinces. Moreover, the paper highlights four major areas, which must be considered for jurisdictions attempting the adoption of such a legislation.

Keywords

ARIMA, Intervention analysis, Time-Series, Severe sanctions, Canadian Legislation, Excessive speeding, Fatal collisions.

Introduction

Excessive speeding is an issue on roads all around the world, and many countermeasures have been considered in different provinces to overcome this challenge. Common reasons for exceeding speed limits by extremely high margins are illegal street racing and stunt driving, while speeding generally has multiple causes including simply being late (Prabhakar et al., 1996). However, street racing is not the only motive of excessive speeding.

There is no doubt that, regardless of the motives, excessive speeding puts the offenders at an extreme risk and could also affect the safety of other drivers and road users. Considering three years of data, Nerida L Leal and Watson (2011) found that drivers who were involved in street racing and stunt driving offences had a history of considerably more traffic infringements and crashes compared to non-offenders. Consequently, more attention and significant sanctions have been considered when dealing with such activities.

A form of stronger sanctioning which has often been introduced to supplement licence suspensions is vehicle-related punishment such as vehicle impoundment. Legislative changes enforcing stronger sanctions against excessive speeders have been adopted by many

jurisdictions around the world including three provinces in Canada (British Columbia, Ontario and Quebec). Under the new laws, drivers who violate speed limits by margins deemed to be excessive are subject to a variety of sanctions including immediate licence suspension, higher fines and vehicle impoundment. The three provinces had different thresholds at which they defined excessive speeding and the fines a driver was subject to under the laws varied as well, details of this is provided in Table 1.

This paper aims to analyse the effects of the Excessive Speeding Legislation (ESL) on fatal collision counts at each of the three provinces. In order to account for exposure, collision counts per million litres of fuel sold were also analysed. A total number of six (i.e., 3 provinces, 2 levels - with or without a proxy for exposure) intervention models were developed, and the significance of the intervention was tested in each case. In addition to the statistical assessment, the paper also provides a discussion of the certain aspects of the policy which must be considered before adopting the legislation. This assessment provides other jurisdictions in Canada and around the world with valuable information which could help in decision making regarding adoption of the ESL.

Literature review

According to deterrence theory, compliance to laws and legislation is mainly due to the fear of being caught. This fear is known to deter (discourage) drivers from violating the law and is a function of three factors: (1) the apparent *severity* of the law, (2) the *certainly and the speed* in which an offender is penalised, and (3) the *administrative penalties* associated with the law (Watson, 2004). Moreover, deterrence is also a function of the amount of enforcement and publicity a law receives (WHO, 2015).

In the past, speeding offenders were mainly subject to monetary fines and demerit points, however, while these penalties have been effective in deterring some drivers, the laws have not been as effective when dealing with aggressive drivers such as excessive speeders. Castillo-Manzano and Castro-Nuño (2012) found that positive safety impacts of demerit points die out rapidly, with the study showing that effects vanish within 18 months of the introduction of the policy. Furthermore, in a study on factors influencing driver speed, Fleiter, Lennon, and Watson (2010) revealed that apart from financial stress,

monetary fines did not seem to have any deterrence effects on excessive speeders.

In an attempt to achieve higher deterrence rates, stronger sanctions including licence suspensions and vehicle related sanctions have been used by legislators. Licence suspensions were first introduced as penalties against drivers who are convicted of DUI. This was found to have encouraging specific deterrence effects (Homel, 1989; Mann, Vingilis, Gavin, Adlaf, & Anglin, 1991), however, not many studies were able to find general deterrence effects for post-conviction licence suspension (Asbridge et al., 2009). As a result, administrative licence suspensions (ALS), where licence suspension occurs before conviction, were adopted. ALS was found to have a general deterrence effect in many studies ((Asbridge et al., 2009); Wagenaar and Maldonado-Molina (2007).

As a means of ensuring suspended drivers did not drive while suspended (DWS), ALS laws were combined with vehicle related sanctions. Voas and DeYoung (2002) provide a summary of most studies that worked on evaluating vehicle impoundment and forfeiture policies prior to their study.

Most studies that have evaluated this type of legislation conclude that vehicle impoundment has an effect on specific deterrence (i.e. drivers who were sanctioned under the law did stop DWS after being sanctioned), and hence, an alleged improvement in the safety of other road users see, for examples, DeYoung (1999) and Voas, Tippetts, and Taylor (1997). Unlike findings pointing to a specific deterrence effect, most studies could not find general deterrence effects of vehicle impoundment laws, see for example, DeYoung (2000) and (N. Leal, Watson, Armstrong, & King, 2009). It is worth noting however, that Beirness and Beasley (2014) was able to find a general deterrence effect for impoundments issued for DUI in British Columbia, Canada.

Meirambayeva, Vingilis, Zou, et al. (2014) studied the effects of the ESL on violation rates (i.e. the number of drivers caught driving at excessive speeds) in Ontario. The violations before and after the introduction of the law were compared, and it was found that the rates dropped for males since the introduction of the law (general deterrent effect); whereas, the rates were almost constant for females. This finding is reasonable considering that males are more likely than females to be involved in excessive speeding activities.

Table 1: ESL at the different provinces

Province	Margin (kph)	Sanctions	
		1st Offence	2nd Offence
BC	40	7day LC & VI, \$368/483 fine, 3pts, \$210 fee	30day VI, \$700 fee
ON	50	7day LC & VI, [\$2,000 to \$10,000 fine, 6 pts, jail term, 2yr LC]*	10yr LC
QC	40/60 zone, 50/60-90zone, 60/100 zone	7day LC, Double fines and points	30day LC & VI, double fines.

LC: Licence Suspension, VI: Vehicle Impoundment.

*After Conviction

Table 2: Descriptive statistics for monthly fatal collisions at the three provinces

Number of Observations				Monthly Collisions			
Province	Total	Pre-Law	Post-Law	Minimum	Maximum	Mean	Std. Deviation
BC	97	57	40	11	46	25.57	7.124
ON	125	73	52	19	85	53.79	14.082
QC	122	52	70	18	80	42.03	13.266

Nerida Louise Leal (2010), who assessed the effects of anti-street racing/stunt driving laws on violations in Queensland, Australia, found that the vehicle impoundment policy did result in the reduction of street racing/stunt driving infringements in the offender sample (specific deterrence).

In one of the few papers which studied the road safety impacts of ESL, Meirambayeva, Vingilis, McLeod, et al. (2014) used time series analysis to assess the effects of the ESL on fatalities. The study found that the policy was effective in reducing speed-related casualties for the young male age group of 16-25 years in Ontario, with a statistically significant drop of 58 casualties per month observed. However, there was no effect for ‘mature’ males aged 26-65 years.

In general, previous studies show that there is some sort of deterrence effect associated with imposing strong sanctions for drivers who commit extreme offences with high crash risk to themselves and other road users. Nevertheless, policy makers are often reluctant to implement these laws due to a number of issues. Notable issues include the liability issues, legal issues and even funding burdens. (Peck & Voas, 2002; Voas and DeYoung (2002); Voas, Tippetts, & Taylor, 2000) provide a thorough discussion of those issues.

Dataset description

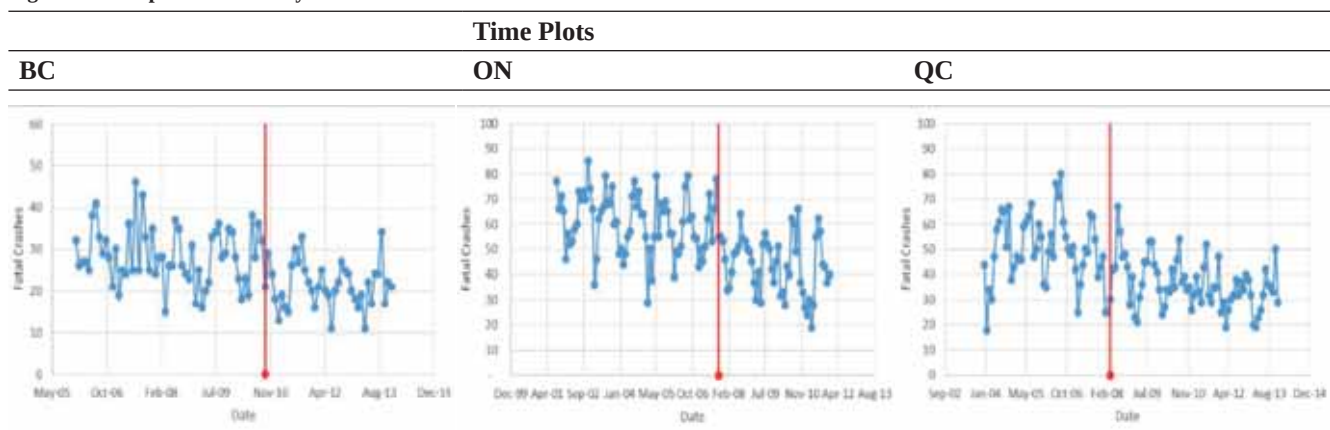
The data used in the analysis included fatal collisions recorded in the three provinces of interest. The collision data covered a period of time before implementing the law and after the law came into effect. The data was obtained

from Ontario Road Safety Annual Reports (ORSAR) kept by Ontario’s Ministry of Transport (MTO), Insurance Corporation of British Columbia (ICBC), and Société de l’assurance automobile du Québec (SAAQ).

The overall time trends of the data are provided in Figure 1; the intervention date is also marked on each of the figures. Moreover, the descriptive statistics of the data are found in Table 2.

In order to avoid potential biases in the results, exposure measures had to be included in the analysis. Since vehicle miles travelled (VMT) per month were not available, a surrogate measure of exposure was collected. Motor vehicle fuel sales per month at each province, kept by Statistics Canada, were assembled for a similar period of time during which collision counts were available and were used in the analysis. Fuel sales have been used as a measure of traffic exposure in previous studies as well, see, for example, (Lasse Fridstrøm, 1999; L Fridstrøm, Ifver, Ingebrigtsen, Kulmala, & Thomsen, 1993). It is worth noting here that despite increases in fuel efficiency over time fuel consumption over the years follows a similar trend to VMT (Goodwin, Dargay, & Hanly, 2004). The reason here is twofold (i) fuel is an inelastic product and (ii) when fuel efficiency increases there is more tendency to travel.

In addition to collision counts and exposure measures, information regarding the implementation or withdrawal of traffic laws affecting collisions during the analysis period was essential. The policies, which took place during the analysis period at the provinces, can be found in Table 3. Since the analysis was conducted on a province-

Figure 1: Time plots for monthly collision data

level (aggregate level), it is fitting to assume that local (disaggregate) safety improvement such as changes in speed/enforcement improvements in a certain town or city did not affect the analysis.

Methodology

Autoregressive Integrated Moving Average (ARIMA) intervention analysis was used to model the data. The process involves using the Box-Jenkins methodology developed by Box and Jenkins (1976) to estimate an ARIMA model for the pre-intervention data and then performing an interrupted time series analysis to assess the magnitude and the significance of the effect of any intervention. While taking into account autocorrelations (correlation between observations from consecutive time periods), ARIMA intervention analysis also permits the addition of covariates to the model such as intervention terms; these terms can then be used in assessing the intervention effects.

In an ARIMA analysis the time series Y_t is assumed to follow an Autoregressive Integrated Moving Average model, which includes three terms (p , d , q):

ARIMA (p , d , q)(P , D , Q) s

Where, p represents the number of autoregressive (AR)

terms; d represents the number of differences required in case of a non-stationary series; and q represents the number of moving average (MA) terms, s represents the number of periods per season and the uppercase terms represent the seasonal part of the model.

The notation of the ARIMA model proceeds as follows. Let Y_t represent the time series, where Y_t is the observation at time t , and let α_t (error term) be a white noise process, $\alpha_t \sim N(0, \sigma^2)$. If B were to represent the backward shift operator of the seasonal period, defined such that $B^k Y_t = Y_{t-k}$, then the ARIMA equation can be written as follows:

$$(1 - \varphi_1 B^1 - \dots - \varphi_p B^p)(1 - \phi_1 B^{(s \times 1)} - \dots - \phi_p B^{p \times s})(1 - B)^d (1 - B)^D Y_t = [1] \\ (1 - \vartheta_1 B^1 - \dots - \vartheta_q B^q)(1 - \theta_1 B^{(s \times 1)} - \dots - \theta_Q B^{Q \times s}) \alpha_t$$

Where, φ_1 to φ_p are the non-seasonal AR parameters; ϕ_1 to ϕ_p are the seasonal AR parameters; ϑ_1 to ϑ_q are the non-seasonal MA parameters; and θ_1 to θ_Q are the seasonal MA parameters.

The Box-Jenkins methodology is a four-step iterative procedure which involves tentative identification, model estimation, diagnostic checking and forecasting. These steps are applied to the pre-intervention data to develop an ARIMA model, which is then combined with a transfer function to perform the intervention analysis. Since the methodology works only for a stable dataset, the effects of

Table 3: All legislative changes during study period

Province	Major Legislation Within the Study Period			
	Type	Implemented/Cancelled	Month	Year
BC	Distracted Driving Law (DDL)	Implemented	Feb	2010
	Impaired Driving (IDL)	Implemented	Sept	2010
	Excessive Speeding Law (ESL)	Implemented	Sept	2010
	Impaired Driving Law	Cancelled	Nov	2011
ON	Excessive Speeding Law (ESL)	Implemented	Oct	2007
	Speed Limiter Legislation For Trucks (Truck)	Implemented	Jan	2009
	Impaired Driving Law: Drivers with BAC .05-.08 lose licence. (IDL-BAC)	Implemented	May	2009
	Distracted Driving	Implemented	Oct	2009
	Impaired Driving Law: Drivers under 21 subject to automatic suspension for alcohol in breath. (IDL-u21)	Implemented	Aug	2010
	Impaired Driving (IDL)	Implemented	Dec	2010
QC	Distracted Driving Law (DDL)	Implemented	Apr	2008
	Excessive Speeding Law (ESL)	Implemented	Apr	2008
	Impaired Driving (IDL)	Implemented	Dec	2008
	Truck	Implemented	Jan	2009

the seasonal variation within the data as well as long-term trends in the data must be removed before applying any of the steps.

As first demonstrated by Box and Tiao (1975), transfer functions can be used to model an intervention effect and determine whether there is evidence that a change in the series has actually occurred and, if so, its nature and magnitude.

Intervention analysis involves assessing the effects of an intervention by introducing an intervention term into the ARIMA model. The intervention term is represented through a transfer function, which models the behaviour of the change in the series. In intervention models, after suitable transformation, the general model for the ARIMA time series Y_t previously shown in equation 1 becomes:

$$(1 - \phi_1 B^1 - \dots - \phi_p B^p)(1 - \varphi_1 B^{(sx1)} \dots - \varphi_p B^{Ps})(1 - B)^d (1 - B)^D Y_t = [2] \\ (1 - \theta_1 B^1 - \dots - \theta_q B^q)(1 - \theta_1 B^{(sx1)} \dots - \theta_q B^{Qs}) \alpha_t + \omega I_t$$

Where, ω is the intervention parameter representing an unknown permanent change in the mean due to the intervention, and I_t is the function modelling the effect of the intervention on the mean level of the series. The combination of ωI_t is also known as the transfer function.

The effect of the intervention on the mean function was represented using a step function.

$$I_t = \begin{cases} 0 & \text{if } t < T \\ 1 & \text{if } T \geq t \end{cases} \quad [3]$$

where, T is the time (t) at which the intervention was implemented.

Modelling Procedure

As already mentioned, developing ARIMA models for time series data is an iterative process. The time trends of the pre-intervention data were first observed to ensure that the data was stationary and that no differencing or transformations were required. In addition to checking for non-stationarity by inspection, the Augmented Dicky Fuller (ADF) test was run for each of the datasets.

The test showed that only data from Quebec was non-stationary, however, differencing resolved the issue. The variance was also constant; therefore, the analysis was performed on the actual collision counts.

After testing for stationarity, correlation structures were explored. In each case, the plots of the ACF (autocorrelation) and the PACF (partial autocorrelation) functions were observed to help identify the order appropriate for a tentative ARIMA model. The parameters for this model were then estimated using the pre-intervention data only. Diagnosis of the tentative model was then performed by:

- Ensuring that the residuals represent white noise (i.e. the residuals are random with no patterns). This was done by checking the ACF plots of the residuals and by running the Box-Ljung test (a portmanteau test that tests the overall randomness of the series based on a number of lags). A large p -value (>0.1) indicates randomness, which was the case in all models.
- Checking the significance of the parameters in the selected model.
- Comparing the Akaike information criterion (AIC) of different models (a measure of relative statistical model quality). The model with the lowest AIC was selected.

If the model did not satisfy the requirements, a different model was estimated and assessed. After several iterations, the best fit ARIMA model was identified.

Intervention modelling

In the ARIMA intervention analysis process, the ARIMA model developed for the pre-intervention data is combined with a transfer function that best captures the hypothesised change due to the intervention. This combined model is known as the ARIMAX model.

Estimating the parameters of the ARIMAX model was done using the full dataset (pre- and post-intervention data). The same diagnostic checks of the Box-Jenkins procedure were applied to the ARIMAX model and adjustments were made to the model when required. Other policies, which took place during the study period, were also integrated into the ARIMAX model. After finalising the models, the significance of the model parameters including the intervention term was assessed.

All stages of analysis were carried out using statistical analysis software R v3.1.1. In order to account for exposure, the number of collisions per million litres of gasoline sold was computed. The gasoline sale estimates represented the sales of fuel used by road motor vehicles only.

The orders of the ARIMAX models selected, along with the AIC estimate, are presented in Table 4. Table 5 shows the parameter estimates for all the models, in addition to the standard error associated with each estimate. This also includes the estimates computed for the intervention terms in every model. Abbreviations are used to represent the policy names, and more information about these policies can be found in Table 3.

Table 4: ARIMAX models selected

Province	ARIMAX Model Order	AIC	Box-Ljung <i>p</i> -value
ON	(0,0,0)(1,1,2) ₆	852	0.718
BC	(0,0,2)(0,1,1) ₁₂	539	0.461
QC	(1,1,1)(0,1,1) ₁₂	1420	0.246

For further verification of the model's fit, fitted figures for each of the estimated models were plotted. It was evident from the plots (not shown) that the models almost replicated the trends in the original data. The Box-Ljung test, which is a portmanteau test indicating randomness of the residuals if the test is insignificant ($p\text{-value} > 0.1$), recorded in Table 4, also indicate that the residuals of each model are random and the model is a good fit of the data; this behaviour is also reflected in the ACF plot of the residuals (not shown in the paper).

The effects of the ESL on fatal collisions at the three provinces are summarised in Table 6, where a significance level of 5% is used. The next few paragraphs provide further discussion of the results. As evident in the table,

the models show that the legislative changes related to excessive speeding were associated with a drop in average monthly fatal collisions at all three provinces, however, the drop was only statistically significant at two of those three. In Ontario, it was found that the legislative change related to excessive speeding was associated with a statistically significant drop in fatal collisions; the mean number of monthly fatal collisions for the post-intervention period decreased by 11 monthly fatal collisions (18.3%) when compared to the average in the pre-intervention time period. In British Columbia, the findings with respect to fatal collisions were similar to those observed in Ontario. The trend dropped by around six fatal collisions (22%) for the post-intervention period, a decrease that was deemed statistically significant.

Table 5: Parameter estimates for developed models

	Par ^a	Est ^b	S.E. ^c		Par ^a	Est ^b	S.E. ^c		Par ^a	Est ^b	S.E. ^c
ON	sar1	-0.9999	0.001	BC	ma1	-0.0435	0.107	QC	ar1	0.196	0.162
	sma1	0.1306	0.095		ma2	0.3036	0.139		ma1	-0.929	0.143
	sma2	-0.8375	0.090		sma1	-0.6945	0.159		sma1	-0.764	0.122
	ESL-	-11.1188	2.239		ESL-	-6.2786	2.394		ESL-	-2.736	5.529
	IDL-BAC-	-7.7041	4.846		IDL-	2.5322	1.946		IDL-	-14.079	7.950
	DDL-	2.1747	3.871		DDL-	-1.9927	2.220		Truck	11.370	7.779
	IDL-u21-	2.5638	4.239								
	IDL-Test-	-7.7211	4.075								
	Truck	0.4953	4.010								

^aPar: Model Parameter, ^bEst: Parameter Estimate, ^cS.E.: Standard Error. Modelling Results

Table 6: Intervention parameter estimates and significance

Effect	%Change in Monthly Fatal Crashes	<i>p</i> -value
Ontario		
-11.12	-18.3%	<0.01
British Columbia		
-6.28	-22%	<0.01
Quebec		
-2.736	-5%	0.621

* $p\text{-value} < 0.05$ indicates significant effect

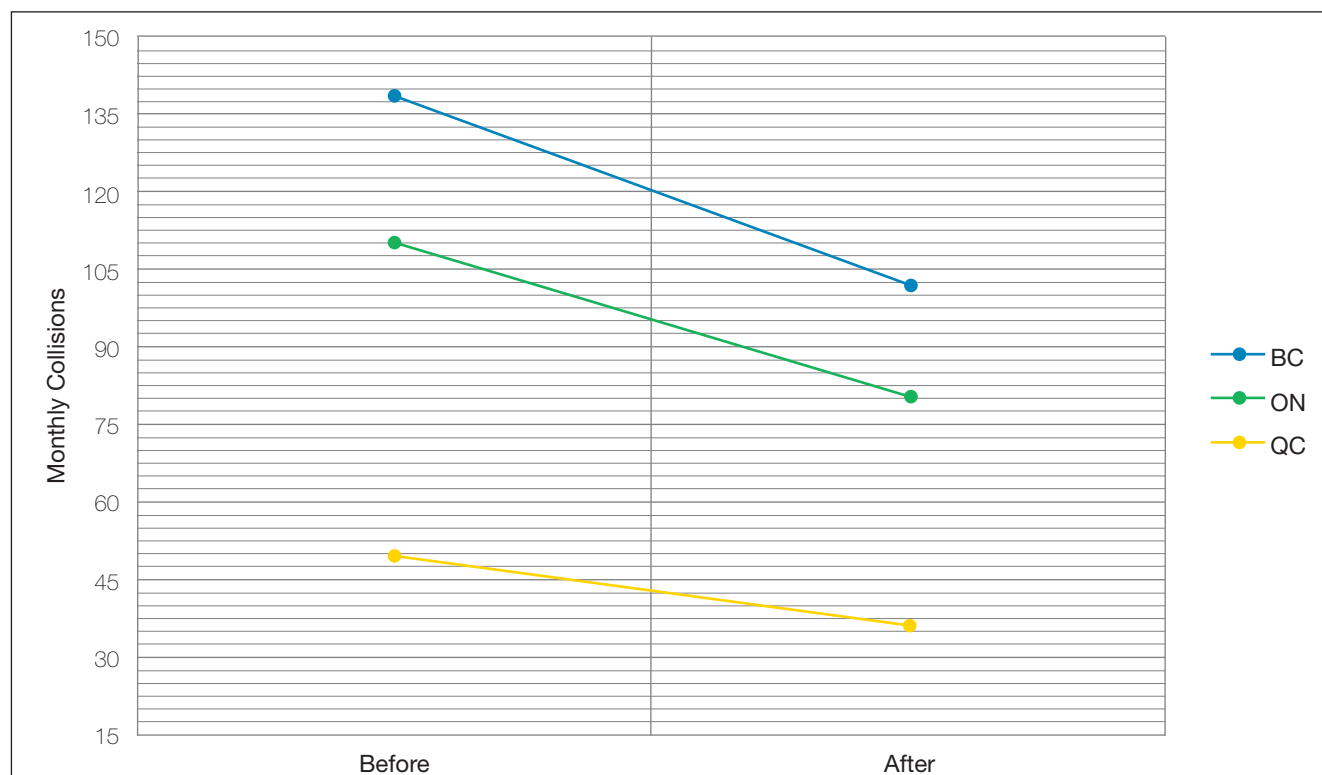


Figure 2: Change in the mean level of monthly fatal collisions

Modelling fatal collision data for Quebec showed that the post-intervention data had a slightly lower mean number of fatal crashes when compared to pre-intervention. The drop was quantified to be almost three collisions (5%); however, unlike Ontario and BC, the change was not statistically significant. It is worth noting here that the observations at each of the three provinces did not change when the exposure-based analysis was conducted.

The fact that the change was not statistically significant in Quebec could be down to the difference in the sanctioning strategy between QC and the other two provinces (this is discussed further in the next section). Another important point to note is that the effects of the policy might not be immediate. Depending on the publicity and enforcement rates, it could take some time for the law to have significant effects. Finally, it is worth noting that a DDL was implemented at the same date as the ESL in QC. This makes it statistically impossible to separate the impacts of the two laws given the current dataset since, unlike the case of BC where the IDL was discontinued, in QC both laws (ESL and DDL) were in place throughout the whole study period.

In general, the results show that the initial hypothesis that the legislative changes related to excessive speeding were effective in reducing fatal collisions are valid. The introduction of the policy changes was associated with a statistically significant drop in the mean number of fatal crashes at two provinces, which points towards the presence of some general deterrence effect. In other words, the

introduction of the law possibly influenced speeders in general to reduce their speeds, hence, a reduction in fatal crashes.

The results are also consistent with other work assessing the impacts of ESL. Brubacher et al. (2014) observed a 21% reduction in fatalities since the inception of the policy in BC. Similarly, Meirambayeva, Vingilis, McLeod, et al. (2014), found that Ontario's policy was effective in reducing speed-related casualties for males in the young male age group of 16-25 years. In fact, this study extends on the findings observed in previous work through the analysis of fatal collisions of different causes. The analysis shows that the impacts of the policy extend to include all fatal collisions. This is reasonable when considering that, while speed might not be the main factor in all severe collisions, it is still one of the contributing factors in those type of collisions.

Policy discussion

Given the positive effects of the ESL at the provinces analysed in this study, other jurisdictions in Canada and around the world might be interested in adopting the policy. Nevertheless, as with any legislative change, adopting the policy requires considering a number of factors. In this paper, four important factors are identified and discussed.

One factor which must be taken into account before adopting the policy is the definition of excessive speeding. As already noted, the literature lacks a specific definition

of excessive speeding, in other words, the threshold over the speed limit above which vehicles are considered excessively speeding is defined locally by each jurisdiction. In Ontario, for instance, a 50kph threshold was used. BC, on the other hand, defined excessive speeding as driving at 40kph over the speed limit. In Quebec, a different approach was used by which the threshold differed based on the speed limit of the road.

Some jurisdictions might be interested in making the laws as stringent as possible by using the 40kph or 30kph threshold. Other locations might use a more scientific approach by considering percentile speeds of vehicles on local highways and defining the threshold based on that data. Regardless of the approach, it is important that highway agencies take this into consideration when adopting the policy.

Another factor which must be considered before implementing the law is the structure of the sanctioning system. This is also something which was different among the three provinces analysed in this paper. In Quebec, only second time offenders were subject to vehicle impoundment. This was not the case in BC and Ontario where a violator's vehicle was impounded even if it was their first offence. The impoundment and licence suspension period are also things which must be clearly specified in the law. In Canadian provinces, typical practice included a seven-day impoundment/suspension for the first offence and 30 days for the second offence. In fact, dealing with repeat offenders is also an important aspect of the law since it has significant impacts on specific deterrence effects of the policy.

The structure of the sanctioning system must also be made clear to the public as legislators could run into disputes with offenders if the law is not properly publicised. Publicity of the law and the means by which this is achieved are extremely important matters particularly during the first few months of the legislation. Not only does this limit the amount of disputes for offenders caught under the legislation, but it also increases the general deterrence effects of the policy.

Another important factor which increases the general deterrence effects is the amount of enforcement the law receives and the timings and means by which it is conducted. Typically, enforcement practice can be automated, manned, covert or overt etc. Unfortunately, when dealing with excessive speeding offences there are some limitations on the types of enforcement that could be used. Since the laws typically involve administrative licence suspensions and vehicle impoundments, the presence of an officer at the site is essential for this to take place and hence automated enforcement is not practical for immediate action although rapid follow-up of offenders is an option following automated detection. On-site officers involve a considerable amount of resources to be deployed at enforcement locations depending on the enforcement schedule defined. Towing and storage of impounded vehicles are also matters worth considering by enforcement officials before implementing the policy. However,

alternative options for disabling vehicle access such as registration plate confiscation and wheel locks may reduce costs, or costs may be charged to offenders.

Conclusions and recommendations

Overall, the findings of this study represents valuable information for jurisdictions considering adopting the Excessive Speeding Legislation. In addition to highlighting the positive safety impacts of the legislation, this paper discusses the importance of considering several aspects including appropriately defining the thresholds at which a driver is considered excessively speeding; carefully defining the structure of the sanctioning system; understanding and managing the enforcement resources required for implementing the policy; and finally, the importance of running an effective publicity campaign informing the public of the legislative changes.

Although the paper does provide some important insight into the safety effects and challenges associated with adopting the ESL, there are opportunities for future research to build on this study. One way to build on this study is to assess the effects of publicity and enforcement rates within the analysed provinces. Analysing those aspects of the law and comparing them among the different provinces could provide answers to the enforcement and publicity challenges highlighted in the policy discussion section of this paper. Future work might also consider analysing the specific deterrent effect of the legislative changes (i.e. understanding how the policy affects those caught under the new legislation) if data on individual records becomes available.

Acknowledgements

This study was sponsored jointly by NSERC Discovery Grant, the City of Edmonton's Office of Traffic Safety (OTS) and Edmonton's Police Service (EPS).

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Principles of road design under a Safe System

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Abstract

The Safe System requires a paradigm shift in the way road designers and project managers think about road safety. Road designers, builders, operators and those that manage roads all have a key role in providing a road that is safe for all users.

This paper outlines various deficiencies in the traditional road design philosophy and proposes a new road design approach based on the Safe System. Key milestones in the evolution of international policy on the Safe System are outlined including its adoption as a guiding principle for the United Nations Decade of Action for Road Safety (2011-2020).

The traditional “blame the victim” approach is contested. The science behind the Safe System and “what works” is well established. This paper provides a brief summary of the key principles to designing a safe road. The next step is to ensure the systematic application of these principles in road design.

Keywords

Safe System, Road design

Introduction and approach

Road safety is an evidence-based process involving the systematic assessment and application of measures to create a road transport system that protects road users from fatal and serious injury. A Safe System is one in which all key elements of the road transport system (Roads, Vehicles and Speed) interact in a way that does not lead to death or serious injury. This requires a new approach to road design whereby road safety is fully integrated into the process. This is in contrast to the traditional approach whereby road safety is viewed as an “add-on” to the road design process in an effort to make the road “as safe as possible”.

Whilst society as a whole has grown accustomed to the way roads look, it is important to remember that road design has been an evolving process rather than a revolutionary one. The first roads were spontaneously formed by humans and animals walking the same paths over and over in the pursuit of food and water (Lay, 1999). As towns and villages began to form, these paths became formal roads to facilitate the transport of goods. Not only did these early “tracks” evolve into the modern roads we now know, but they did so through an era where speed was of little concern or consequence.

One need only consider the absurd, yet widely accepted,

situation now where society accepts driving on a single carriageway road with nothing more than a painted line to separate vehicles travelling in opposite directions at speeds in excess of 100km/h. The problem is that this type of road transport system is inherently unsafe; in this system it is a case of when, not if, a fatal or serious injury crash will occur. Yet, this has become such the norm that most road safety auditors would not raise this as a concern. Ultimately, road design has failed to keep up with vehicles that are now travelling at speeds far in excess of the human body’s ability to withstand serious injury.

The purpose of this paper is to investigate how well Safe System principles are embedded in current road design standards and processes. A brief overview is provided on the Safe System and how it has evolved. The limitations of the traditional approach to road design are highlighted and then compared and contrasted with the Safe System. The key crash types that underlie the Safe System are discussed with a brief reference to the vehicle safety industry, noting how it has evolved from a fatalistic (blaming the user) approach to a model based on mitigating key crash types.

The paper recommends a set of principles to be integrated into road design guides to achieve a safe road. Practical examples are provided to illustrate the Safe System in practice.

The priority in designing and constructing a road must be that it is safe. The tools to achieve a safe road are well established. The challenge is to implement them systematically and on a scale large enough to bring about significant reductions in serious road trauma.

International policy on the Safe System

Growing international concern about the humanitarian toll associated with road trauma ultimately led to the first world report on traffic safety in 2004 (WHO, 2004). This was followed by an International Ministerial Conference on Road Safety hosted by the Russian Government in Moscow in 2009. The United Nations General Assembly later proclaimed the Decade of Action for Road Safety 2011-2020, which was officially launched in May 2011.

The Moscow Declaration (UN, 2009) acknowledged the findings of a report prepared by the International Transport Forum and the Organization for Economic Cooperation and Development - *Towards zero: ambitious road safety targets and the safe system approach* (OECD, 2008) - and its recommendation that all countries regardless of their level of road safety performance move to a safe system.

The Moscow Declaration then resolved to “Set ambitious yet feasible national road traffic reduction targets that are clearly linked to planned investments and policy initiatives and mobilize the necessary resources to enable effective and sustainable implementation to achieve targets in the framework of a safe system approach”.

The Safe System underpins the Global Plan for the Decade of Action for Road Safety 2011-2020 (UN, 2011). The Global Plan calls for national activities under the Safe System pillar of Safer Roads to “Promote road safety ownership and accountability among road authorities, road engineers and urban planners by promoting the safe system approach and the role of self-explaining and forgiving road infrastructure”.

RTA (2011) includes an overview of the Safe System and an historic account of its development. Key documents on the Safe System include the Organization of Economic Cooperation and Development’s (OECD) report *Towards Zero: Ambitious Road Safety Targets* and PIARC’s *Road Safety Manual*.

Traditional approach versus Safe System approach to road safety

While roads have been constructed since antiquity, it is only since the 1940’s that post-war road construction expanded rapidly. The passing of the USA Federal-Aid Highway Act 1944 led to standardising the science of road design. While in the intervening years there have been numerous improvements in how roads are designed (Hasson, 2010 and Hasson, 2015), the core fundamentals remain: traffic flow and forecast growth; intersection type and design; geometric alignment and design; and pavement material and design (Rogers, 2002).

Shaheen sought to apply safety principles to the traditional approach. He identified the key design controls as: design speed; design vehicle; human factors; traffic volume; capacity and level of service; pedestrians and cyclists; and intersection and access control. He then introduced the significance of design speed on road user safety in terms of affecting injury severity outcome and discussed the concept of target speed, which seeks to use road engineering elements to influence travelling speed (Shaheen, 2014). This approach provides a greater appreciation of the impact of speed on safety but still relies on the traditional engineering design paradigm. Safety is not a leading object of design but a consequence of how design principles are applied.

In contrast, Hauer was critical of the engineering approach that sought to quantify human behaviour as a set of measurable factors. He observed that engineers are trained to manage inanimate objects whose properties are well known and can be quantified (Hauer, 1999). When a similar approach is used to define road user properties and the user does not behave as expected, it is seen as an uncontrollable outcome. Road safety professionals refer to this as “blaming the user”. Under the Safe System the designer has a responsibility to design a road that is safe for

all users acknowledging that user performance is limited. Hauer argues that road design should be based on road safety outcomes, such as “expected frequency of crashes or crash consequences”, rather than using road safety proxies (Hauer, 1999), such as human factors.

Scandinavian research shows that even if all road users complied with road rules, fatalities would only fall by around 50% and injuries by 30% (Elvik et al., 2009). This is supported by comprehensive studies undertaken in South Australia which found that very few non-fatal crashes (3% metropolitan, 9% rural) involved extreme behaviour and, even in fatal crashes, the majority (57%) were due to system failures (Wundersitz and Baldock, 2011).

From an engineering perspective, the traditional approach to road safety is considered in terms favoured by economists as negative externalities, i.e. the unintended but unavoidable downside of an essential road transport system. Economists argue for the safest system that can be affordably achieved, based on a balance between the economic benefits of measures to reduce risk versus the cost required to implement these measures (cost-benefit analysis). These negative externalities are the equivalent of collateral damage (Johnston et al. 2014), i.e. the price we must pay as a society.

Acceptable levels of road safety are traditionally set based on the lowest level of risk that can be achieved at a reasonable cost. This approach forms the basis of the ALARP (As Low As Reasonably Practical) principle. ALARP was originally developed for industrial safety and is based on risk matrices that identify all possible risks, which are then systematically assessed in terms of probability and severity. Such an approach, when applied to the road transport system, focuses on risk of crashes rather than preventing injuries, assumes a level of collateral damage and is largely disregarded in any case in favour of a cost-benefit approach based on available funds. This leads to trade-offs being made between safety on one hand and mobility and access on the other.

For example, the UK’s TD 19/06 Requirement for Road Restraint Systems and supporting Road Restraint Risk Assessment Process (RRRAP) uses a risk based approach to identify locations for safety barriers. Risks that are considered “tolerable” are treated using the ALARP principle, for which all reasonably practical efforts must be taken to lower the risk to “broadly acceptable”. To define reasonably practical the “risk has to be weighed against the trouble, time and money needed to control or remove it” (DMRB, 2006). Clearly this is counter to Safe System principles and should not be considered acceptable when designing a road.

In contrast, the goal of the Safe System is to ensure that when crashes occur they do not result in death or serious injury. At the centre of the Safe System is the recognition that no-one should accept serious road trauma as an inevitable consequence of using the road.

Table 1. Traditional Approach versus Safe System (developed from Belin, 2012)

Traditional Approach	Safe System Approach
Focus on Crashes Aim to reduce risk of crashes	Focus on Injuries Aim to eliminate death and serious injury
Road user has primary responsibility	System designer has primary responsibility
Change individual road user behaviour	Change the environment (safe roads, safe vehicles, safe speeds). The system is designed according to human capability and human tolerance to crash forces
Safety is “optimised” once mobility and accessibility objectives have been achieved	Safety is a fixed parameter with threshold levels that cannot be exceeded. Mobility and accessibility are variables within this framework
Roads are made as safe as reasonably practical	Roads are self-explaining and forgiving of mistakes such that road users are protected from crash forces that exceed human biomechanical injury thresholds

A safe road is one that is self-explaining and forgiving of mistakes such that road users are protected from excessive crash forces. This requires roads and roadsides to be designed so as to reduce the risk and, most importantly, the severity of crashes.

Key crash types

The Safe System requires a focus on the key crash types that contribute to fatal and serious injury. While it is possible to identify multiple factors influencing crashes, and this exercise is useful in developing targeted countermeasures, it is also possible to identify just four groups of crash types that account for the vast majority of serious crashes resulting in death (Johnston et al, 2014). By changing the core road design assumptions to focus on these four (4) crash types the result will be substantially safer roads.

The key crash types that lead to death and serious injury are:

1. Head-on crashes;
2. Intersection crashes;
3. Run-off-road crashes; and
4. Vulnerable road user crashes.

In New Zealand 88% of high severity crashes and 90% of high severity injuries on rural roads are due to head-on, run-off-road and intersection crashes (NZTA, 2011).

In Australia (Australian Government, 2015), the following four key crash types represent 86.1% of fatalities (2013 data):

- Head-on crashes (17.7%);
- Intersection crashes (21.8%);
- Single vehicle run-off-road crashes (33.3%); and

- Pedestrian crashes (13.3%).

In the United States (NHTSA, 2015), the following four key crash types represent 86.6% of all fatal crashes (2013 data):

- Head-on crashes (9.3%);
- Angle crashes (17.9%);
- Crashes with fixed objects and rollover (42.3%); and
- Collisions with pedestrians and cyclists (17.1%).

These crash types represent the key focus areas for road designers and planners to ensure a safe road.

The importance of speed

The designer must understand the significance of speed in relation to each of the key crash types, as the human body's tolerance to physical force is at the centre of the Safe System. The single most critical factor that determines the amount of force involved in a crash is speed. The amount of energy involved in a crash increases exponentially with speed:

$$KE = \frac{1}{2}mv^2$$

KE is Kinetic Energy; m is vehicle mass; and v is vehicle speed. Figure 1 illustrates the risk of fatality for the key crash types based on impact speed (RTA, 2011).

Human biomechanical injury tolerance for a pedestrian hit by a car will be exceeded if the vehicle is travelling at more than 30 km/h. Likewise, injury tolerance limits will be exceeded for the occupants of a vehicle involved in a head-on crash at speeds greater than 70 km/h; a side-impact crash at speeds greater than 50 km/h; and an impact with a tree or pole at speeds greater than 40km/h. Under a Safe System road users should not be exposed to impacts above the biomechanical threshold speeds (Johansson, 2009).

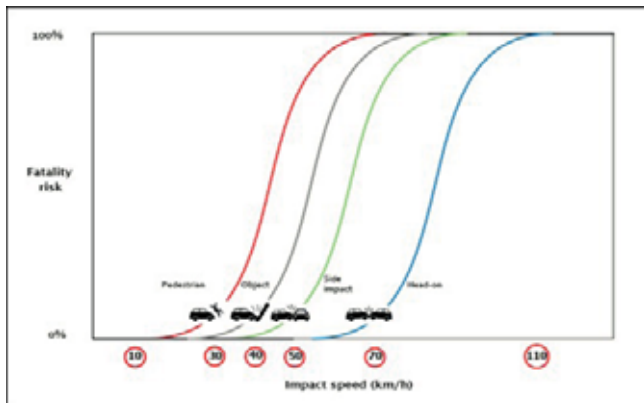


Figure 1. Fatality risk for key crash types at different impact speeds (RTA 2011)

A brief look at the vehicle safety industry

It is interesting to briefly compare improvements to vehicle safety over recent decades. These improvements came about through a combination of litigation, advocacy and legislation (Gavin, 2012). Motor vehicle manufacturers originally argued that they “had no duty to manufacture a product that would be safe in collisions they had no direct part in causing”. However, the court ruled that they had

a duty of care to ensure their design should not expose a vehicle occupant ‘to an unreasonable risk of injury in the event of an accident (Larson v General Motors, 1968 quoted in Gavin, 2012). Motor vehicles manufacturers were no longer able to blame the driver and were obliged to understand the risks associated with their product; and design safety features mitigating these risks.

A key step to testing and improving the design of vehicles was the introduction of the New Car Assessment Program (NCAP) in 1979 (Gavin 2012). NCAP produces a rating of one to five stars, with five stars indicating the highest level of protection within a vehicle’s weight class. Initial NCAP testing in the USA focused on frontal impact crashes (simulating head-on crashes) and later, in 1997, expanded to include side impact testing (simulating intersection type crashes).

The European New Car Assessment Programme (Euro NCAP) was founded in 1997 and includes a frontal test performed at 64 km/h into an offset deformable barrier, a side impact test performed at 50 km/h, a side impact pole test performed at 29 km/h and a range of pedestrian safety tests performed at 40 km/h. These tests simulate the four (4) key crash types (Figure 2).

NCAP was designed to provide safety information to the

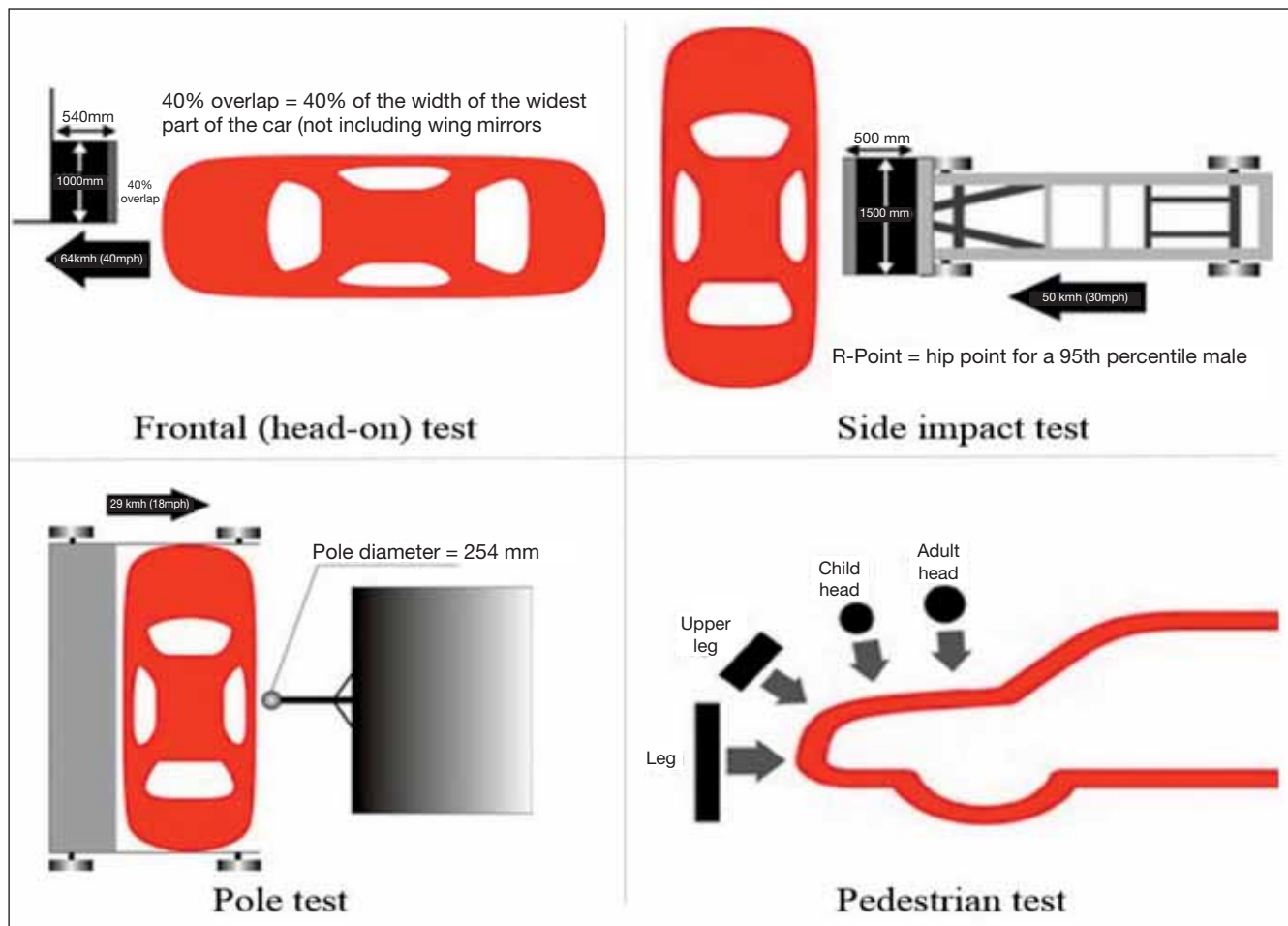


Figure 2. Euro NCAP testing protocols (Euro NCAP, 2016)

public and to improve vehicle safety by providing market incentives for vehicle manufacturers to improve safety. The testing protocols adopted by NCAP have driven substantial vehicle safety improvements in areas that are generally aligned with the four most common crash types that result in death and serious injury.

Principles of road design under a Safe System

“A road is a man-made product. In use, it is known to be harmful to health. It is not acceptable to produce roads and put them into use without providing for a premeditated amount of safety” (Hauer 1999). Hauer also argued that many design standards are based around proxies for safety rather than real safety effects (Hauer 1999). There is now sufficient research to quantify the safety benefits of individual road engineering elements (Austroads, 2012).

There are two ways to achieve a Safe System: either eliminate the potential for these crash types to occur through physical separation or reduce impact speeds at potential conflict points. The designer must consider the expected operating speed as well as the design speed and posted speed limit.

The designer also needs to understand the relationship between crash types, impact speed and severity, and use proven measures to manage them. To address the potential for right-angle crashes at intersections, for example, the designer must either design a safe intersection that eliminates these crash types or use proven methods to control speed. Changing the road environment to influence speeds by the use of road engineering measures is well established (OECD, 2006).

Measures to address head-on crashes include either median barriers to prevent potential conflicts or speed management to reduce impact speeds. Grade separation is an effective measure to prevent potential conflicts at intersections. At-grade intersections can be made safe through speed management and by reducing potential impact angles so as to reduce the transfer of energy in the event of a crash. Roundabouts, for example, require drivers to slow down and reduce potential impact angles. Roundabouts are considered an effective Safe System solution (OECD, 2008). There are multiple examples across the globe of well-designed roundabouts improving safety in very high-speed environments. Roundabouts are also an effective traffic calming solution in low speed residential areas and have a demonstrated safety benefit for all users, including pedestrians (Austroads, 2012).

Traffic signals should not be used in high speed (> 80 km/h) environments (Austroads, 2009). To mitigate the potential for high speed collisions at traffic signals, additional measures should be used to manage speeds, such as raised platforms, and to ensure compliance, such as combined red light and speed cameras.

Run-off road crashes are a major cause of serious road trauma on high-speed roads. Safe roadsides should incorporate measures such as a hardened recoverable space, full-length safety barriers and passively safe roadside furniture. Historically, clear zones have been preferred over road safety barriers, which are often regarded as a hazard. However, conventional assumptions about clear zone standards are being questioned (Larsson et al., 2003) and it is likely that roadside surface conditions may significantly contribute to rollover potential and affect the ability of a high-speed vehicle to regain control. It should also be recognised that full length safety barriers place less demand

Table 2. Safe System design principles to target key crash types

Crash Type	Safe Speed*	Prevention/Segregation	Mitigation/Inclusion
Head on Crashes	70 km/h	Median barriers	Limit potential impact speeds to 70km/h through speed management, particularly with enforcement using average speed cameras.
Intersection Crashes	50 km/h	Grade separation Close intersections Access control	Limit potential impact speeds to 50km/h through speed management and enforcement. Manage speeds and impact angles at intersections by treating with roundabouts and left turn only (drive on left) or right turn only (drive on right) intersections.
Run-off Road Crashes	40 km/h	Remove roadside hazards Provide protection using road safety barriers (road safety barriers may be required even when roadside hazards are removed to prevent rollover, particularly in soft, sandy or uneven roadside conditions)	Install passively safe (frangible/energy absorbing) roadside infrastructure or limit potential impact speeds involving roadside furniture to 40km/h through speed management and enforcement
Pedestrian Crashes	30 km/h	Pedestrian bridges and underpasses Segregated pedestrian/cycle paths protected from vehicles by safety barriers	Limit potential impact speeds to 30km/h through speed management and enforcement

* Road users should not be exposed to impact speeds exceeding these levels

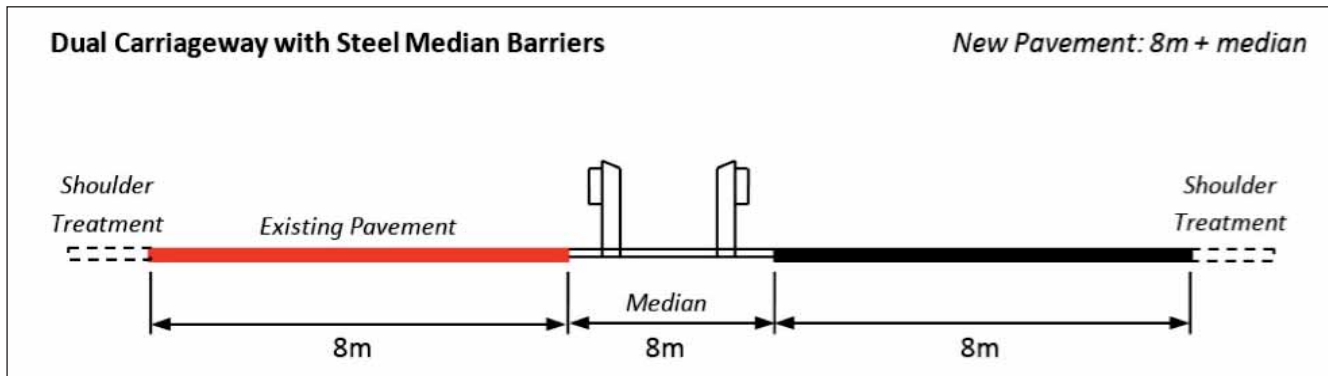


Figure 4. Route 55 upgraded cross section

on road cross-section compared to wide clear zones or wide medians. This can lead to a lower project cost and have a significantly less impact on the environment.

To address the safety of vulnerable users such as pedestrians and cyclists, the designer must identify the function of the road and the likely operating speed of vehicles. The designer must then consider pedestrian facilities that either provide adequate separation from vehicles or implement an effective speed management strategy that ensures no pedestrian will be hit at speeds exceeding the injury threshold. Pedestrian fencing is an effective measure (Austroads, 2012) to direct pedestrians towards safe facilities, noting that if facilities are positioned correctly on desire lines, the need for pedestrian fencing can be minimised. Pedestrian fencing is also an effective measure to prevent pedestrians from entering or crossing higher speed roads.

It is also important that road designers are engaged with enforcement agencies to ensure that effective enforcement measures are integrated into the road design and planning process. There are many proven benefits to automated enforcement measures (Austroads, 2012 & Austroads, 2004). For example, automated average speed or point-to-point speed enforcement systems should be considered as standard features on high speed Freeways. Similarly, consideration should be given to fitting combined speed/red light cameras as standard features on traffic signals, particularly in higher speed environments.

Safe System Design Principles

A safe road design requires the designer to address the following questions:

- Is it possible to have a head-on crash at speeds greater than 70 km/h?
- Is it possible to have a right-angle crash at speeds greater than 50 km/h?
- Is it possible to have a side-on crash with non-frangible object at speeds greater than 40 km/h?
- Is it possible to have a pedestrian or cyclist crash at speeds greater than 30 km/h?

An affirmative response to any of these questions means that the Safe System is violated. If this is the case, the

designer should seek to move towards a Safe System compliant design using the key principles outlined in Table 2.

It may be argued that the principles of Safe System design are easier to apply to a new road design. However, the same principles can be applied through remedial works to an existing road. This is common practice as part of extended design domain or brownfields design guides which can be applied incrementally as remedial road safety improvements (Levett, 2009).

Case Study 1: Route 55 (Qatar)

Prior to 2013, Route 55 was a two lane single carriageway road with a history of serious crashes. The types of crashes were consistent with those expected for a high speed rural road, i.e. head-on crashes, run-off-road crashes and intersection crashes.



Figure 3. Route 55 before it was upgraded

Following a multiple fatality head-on crash in 2012, there was an urgent call to improve the safety of the road. As a result, the road was upgraded to four lanes with an 8 metre wide median together with median barriers to separate opposing traffic (two lanes in each direction) and expected to operate at high speed. The upgraded cross section is shown in Figure 4.



Figure 5. Route 55 after the upgrade

All minor accesses and intersections were reconfigured to a right in/right out layout and all left-turn and U-Turn movements were directed to roundabouts at approximately 5 to 10km spacing.



Figure 6. Before – intersection with risk of high severity turning crashes



Figure 7. After – intersection converted to Right In/Right Out configuration

The Route 55 upgrade has virtually eliminated the potential for head-on crashes, through the use of median barriers, and significantly reduced the potential for high severity intersection crashes, by managing all turning movements at roundabouts. While further refinements could have been

made, such as the provision of 1 to 1.5 metre-wide paved shoulders to mitigate run-off-road crashes, this project represents a good example of Safe System adoption. Moreover, it represents a very good demonstration project for other rural roads in Qatar.

Case Study 2: Centennial Highway (New Zealand)

A spate of fatal crashes on Centennial Highway near Wellington, New Zealand in the late 1990's and early 2000's sparked significant public concern (Marsh, 2010). In response, various traditional road safety remedial measures were implemented including upgraded warning signs and extra wide profiled (tactile) centreline markings. These measures were considered to be a success for two years; that is until another two fatal head-on crashes occurred in 2004.

As a result, the speed limit was lowered from 100km/h to 80km/h and a narrow median wire rope barrier installation was implemented (Figure 8).



Figure 8. Centennial Highway

Prior to the median barrier installation there were 12 fatal crashes and four serious injury crashes (1996 to 2004) at an average annual social cost of \$5, 796,899. From 2004 to the end of the evaluation period (2009) there were no fatal or serious injury crashes and the average annual social cost reduced to \$65,400. Analysis of surveillance videos obtained from CCTV cameras installed along the length of the project indicated that vehicles involved in crashes with the wire rope barrier generally sustained very minor damage and were, in many cases, observed to drive away after impact.

This case study highlights the limitations of a traditional approach to road safety and demonstrates how serious road trauma can be significantly reduced through the adoption of Safe System principles.

Discussion

Under the traditional road design paradigm, safety is not a leading object of design but a consequence of how design

principles are applied. The safety of road users should not be reduced to what is considered reasonably practical, where risk is weighed against the trouble, time and money needed to control or remove it. Serious road trauma should not be viewed as an inevitable consequence of using the road.

The principles of segregating conflicts in the transport system and managing impact speeds are universal, that is, they are valid in any country. In a Safe System it is accepted that crashes will occur, but it is not accepted that road users will be killed or seriously injured as a result. The Safe System requires a paradigm shift in the way system designers think about road safety. System designers must recognise and understand human capabilities and injury tolerance constraints as a basis for developing a transport system that protects road users from fatal and serious injuries.

The principles of Safe System design apply to the construction of new roads as well as the retrofitting of remedial works to existing roads. The science behind the Safe System approach and “what works” is well documented and is continuously being refined. The next step is to ensure the systematic application of these principles in road design.

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Contributed Articles

Road safety for all!

by Zoleka Mandela

Global Road Safety Advocate, Founder and Chairman of The Zoleka Mandela Foundation, Breast Cancer Activist and Survivor

My daughter, Zenani Zanethemba Mandela was tragically killed two days after celebrating her 13th birthday in a single vehicle drink-driving crash ahead of the 2010 FIFA World Cup in South Africa. Owing to the tragedy that seized my family, the international Zenani Mandela Campaign for Road Safety was launched in New York City, with the objective of highlighting road safety issues for young people and in support of the United Nations Decade of Action for Road Safety. The specific aim of our campaign is to improve the levels of protection for children, predominantly in developing countries.

Road traffic injury is a global epidemic and a plague upon the young. It is the leading cause of deaths in children between the ages of 10 to 19 years, denying many children an education and imposing poverty on scores of families. In memory of Zenani, a mission was embarked upon to proudly fight for the rights of young people. Albeit the alarming numbers killed on our world's roads annually - more than succumb to diseases such as tuberculosis or malaria or HIV- sufficient attention is not given to this pandemic of young deaths and debilitating injuries.

In aid of the United Nations Global Road Safety Week 2013, the Zenani Mandela Campaign introduced the "Long Short Walk," a campaign to generate protection for global road users that is of better quality. This gives supporters worldwide, the opportunity to highlight roads they consider both dangerous and requiring safety precautions, so that governments are pressed to include road safety into the new Sustainable Development Goals.

We must do more, but we are making progress. Ahead of the global meeting, I visited Booker Hill Primary and Nursery School High Wycombe where children had been learning about global road safety as well as the life of Nelson Mandela and history of South Africa. (Booker Hill Primary and Nursery School, 2015). In a school assembly, I told the teachers and children about the Save Kids Lives campaign which the school will join along with a local road safety project to be carried out with Johnson & Johnson (FIA Foundation, 2015). As a member of the UN Road Safety Collaboration, Janssen together with Johnson & Johnson, have donated roughly a million dollars towards the UN Decade of Action for Road Safety.

"The project is a pioneering approach to road safety, introducing safe road infrastructure to protect school children on the route to and from school, combined with road safety education and awareness for children and teachers from Takalani Sesame and Childsafe" (FIA Foundation, 2014). The fitting of a road traffic light made certain that 1,150 children at the school had a much safer road to travel to school and assisted in preventing vehicles from traveling at 90 km/h.

The Save Kids Lives campaign is for children's road safety and binds policy makers to pledge themselves to long-lasting action to improve road safety for children entirely. The Child Declaration for Road Safety, consistent with the campaign, intensifies the voices of children who are seldom heard, and asks individuals to provide them with safer roads.

The World Health Organization has publicised that half of the individuals who die on the world's roads are Vulnerable Road Users, i.e., motorcyclists, cyclists and pedestrians. The Long Short Walk Campaign emphasises safer walking worldwide, similar to the Safe Schools Project that was launched in South Africa as an initiative of the Decade of Action for Road Safety. Until now, 90% of fatalities on roads around the world have occurred in low and middle income countries, including Africa which has the most dangerous roads in the world.

Leading the launch of the first Safe Schools project in South Africa was an initiative undertaken as part of the Decade of Action for Road Safety. "The project has been initiated by the Road Safety Fund and has been made possible through global support for project work, which is part of the Decade of Action for Road Safety. The project is primarily funded with a donation from Decade of Action global corporate supporter Janssen, a Johnson & Johnson company" (FIA Foundation, 2015).

The world is in need of more road safety role players committed to addressing the challenges facing road safety in the world, to empower the voices of children and many generations to come. With only four years to achieve the Sustainable Development Goals target, urgent action is needed and must be adopted in a global commitment to effective action.

For five years of the Decade of Action, there have been greater efforts to reduce fatalities and injuries on our world's roads yet road deaths have not decreased at the rate required to realistically meet the international goals laid out by the Decade of Action for Road Safety. Road traffic injuries and fatalities are preventable - safe crossings for children on route to school, tougher actions on speeding, drink driving as well as seatbelt and helmet use are existing life saving measures which can protect our children if implemented.

As a result of the 2015 Brasilia Global Conference and accompanied by the UN Resolution in April 2016 to take the global agenda forward on road safety, governments have committed to the ambitious target to halve road fatalities worldwide by the year 2020. As saving lives on the road is an absolute priority; with a greater level of commitment together with an emphasis on ambition and action, averting the 1.24 million road users who are killed on global roads annually will result in a decline in social and economic consequences that destabilise progress toward the Millennium Development Goals.

The World Health Organization refers to an astonishing figure of 1.9 million people as they describe the annual road traffic death forecast by the year 2020. Particularly in low-income countries, innumerable interventions to make progress with road safety have proven unsuccessful due to the lack of sustainable funding. The Safe to Learn report that was launched by the FIA Foundation and UNICEF indicates that no matter the level of income in all countries, the measures to guarantee the safety of its children on the roads can always be enforced (Silverman and Billingsley, 2015).

Much more work is needed to reach the objectives of the Decade of Action and the new global target to halve road fatalities in the Sustainable Development Goals. Therefore, joining together in stronger partnerships – corporations, governments, and civil society - all around the world can create immediate action to ensure that all contributors deploy policies that will protect children and end road traffic injury.

The My World initiative, offering individuals a window of opportunity to vote for better roads and transport, is a means by which a call is conveyed to world leaders to commit to action and the employment of road safety legislation and enforcement. The initiative celebrated reaching five million votes cast in the global public opinion survey, that was intended for the new development goals and responsible for connecting representatives of the public together with policy makers at the United Nations, in relation to the new priorities for global development (FIA Foundation, 2014a).

Developing countries are desperate for the support and partnership of high-income countries with substantial resources and will benefit prominently from practical interventions designed to impact positively on high-risk regions. Issues with reference to road safety influence the safety of school children. Supporting road safety education

will aid in the development of both their attitudes and behaviours, and place further responsibility on all road users in developing and developed nations.

Campaign work can increase international funding and support to encourage road safety initiatives nationally on behalf of children who lose their lives through no fault of their own. With the purpose of creating a greater understanding in our society of this man-made epidemic, an acceleration on how countries respond progressively to dangerous roads and much higher levels of road traffic injury will revive the hope of society and provide deserving children with the opportunity to succeed academically and contribute to their communities.

According to UNICEF, a number of studies conveyed over the past ten years have confirmed a connection between road safety and poverty. "Globally, children in low-income and middle-income countries have a road traffic death rate nearly three times as high as those in high-income countries" (WHO, 2013).

I have been a passionate road safety advocate since the tragic death of my daughter Zenani, and through published articles in the Huffington Post and Youth for Road Safety hope to draw poignant attention on the need to protect the most vulnerable in the world; children and place focus on the #SaveKidsLives campaign (see Youth For Road Safety, 2015).

The Zoleka Mandela Foundation with the aim of increasing the level of road safety awareness within the youth and in schools, supports the Decade of Action for Road Safety and is inspired to further reduce road accidents by means of educating and training road safety ambassadors in South Africa; thus creating road safety experts who will in return, transfer the skills they have been taught into their respective communities to then educate school pupils as well as youth. The Foundation has developed a road safety empowerment programme that relies on the financial support of NGOs, corporates, government and civil society to safeguard the success of its initiative.

The Zenani Mandela Road Safety Scholarship is recognised by the Nelson Mandela Foundation and was launched together with the FIA Foundation's Commission for Global Road Safety at the Make Roads Safe campaign conference that took place in London. South African policy makers confront death and injury on their country's roads by learning from road safety professionals worldwide and restoring road safety in their own communities.

Realistically, road deaths are not appropriately recognised as a developmental crisis despite being a major public health epidemic. Making sustainable transport a priority for all and preventing unwarranted suffering, will necessitate a global intolerance to denying the rights of our children to travel to school.

Notwithstanding that global road death and injury are widespread phenomena that lack precedence and concerted efforts, they remain a crisis that can be put right to each and every child's advantage. Undeniably, our most vulnerable

citizens have human rights too and as the former president of South Africa, the late Nelson Rolihlahla Mandela instructed, we owe our children the right to a life that is free from any violence and fear - to support vulnerable children at risk and to advance the value of their lives. Road crash deaths and injuries are the most profound, most pervasive global violation of the right to a life free from violence. We must address this urgently, committing the resources required to avert this epidemic.

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The Bloomberg Initiative for Global Road Safety 2015-2019: addressing road traffic fatalities in low- and middle-income countries

by Kelly Larson, Rebecca Bavinger and Kelly Henning

Bloomberg Philanthropies

Introduction

Road traffic crashes claim 1.25 million lives each year and severely injure up to 50 million, making it the ninth leading cause of death globally (WHO, 2015). Unless urgent action is taken, the World Health Organization predicts road traffic fatalities will become the world's seventh leading killer by 2030 (WHO, 2014). Beyond the human suffering caused by these preventable deaths, the economic toll is significant, particularly in low- and middle-income countries, where 90% of deaths occur annually (WHO, 2015). The UN Decade of Action for Road Safety 2011-2020 and the inclusion of road safety targets in the UN Sustainable Development Goals have increased global attention, however, urgent action is needed by governments at both

the national and subnational levels to address this public health epidemic.

Bloomberg Philanthropies, recognising that road traffic crashes are a significant public health issue, has invested \$259M since 2007 to address the growing burden of road traffic crashes in low- and middle-income countries. Proven, effective strategies already exist to reduce the risk of death and injury to drivers, riders, passengers, and pedestrians involved in traffic crashes. Bloomberg Philanthropies Initiative for Global Road Safety is funding the world's leading road safety organisations to support national and local governments in low- and middle-income countries to implement interventions proven to reduce crashes and save lives. These interventions include: 1) strengthening road safety legislation; 2) implementing life-saving interventions

that increase seat-belt, child restraint and helmet use, reduce speeding, and eliminate drink-driving; 3) surveying road networks and recommending infrastructure improvements; 4) improving the collection of data to evaluate project effectiveness and better target interventions; and 5) promoting vehicle safety.

In 2015, Bloomberg Philanthropies renewed its commitment to saving lives by improving road safety, investing \$125 million USD over five years to road safety efforts in low- and middle-income countries and cities with a high burden of fatalities and injuries. Benefitting from lessons learned and capitalising on previous successful road safety efforts, Bloomberg Philanthropies refined its approach to ensure the greatest impact by focusing on three key areas: strengthening national legislation; implementing road safety interventions at the municipal level; and promoting vehicle safety.

Strengthening legislation

Strong road safety laws and the implementation of these laws is a key activity in reducing road traffic fatalities. Bloomberg Philanthropies has supported strengthening of road safety laws since 2007 and continues to support the development and passage of road safety laws in China, India, Tanzania, Philippines, and Thailand. Through a legal development program, a cadre of lawyers are being trained on best practice road safety legislation and local organisations funded to advocate for passage of these laws. Journalists receive specialised training to highlight road safety as a significant public health epidemic. In India, Bloomberg Philanthropies grantees have helped draft and are advocating for passage of the comprehensive national Road Safety and Transport Bill. The government of the Philippines recently passed a drink-driving law that prohibits driving with a blood alcohol concentration level over .05%. Bloomberg Philanthropies is supporting a local organisation that will facilitate the implementation of this law in Manila, demonstrating the need for strong implementation nationwide.

Road safety interventions

Cities play a critical role in implementing important road safety interventions, and obtaining high-level political support from the Mayor, or equivalent political leader, is an essential component of any city-level program. Local governments are critical to reducing road traffic deaths, because the most effective, proven strategies are best implemented at the city level; by governments who know their roads and their citizens best. In many countries the majority of the road network is managed by municipal/city level governments. In order to support the important role that cities play in implementing road safety interventions, Bloomberg Philanthropies invited 23 cities, with a population more than 2 million people, to submit proposals to participate in the 2015-2019 Bloomberg Philanthropies Initiative for Global Road Safety. These proposals addressed four key areas: 1) Hard-hitting media campaigns on road user safety-related behaviour – seat-

belt/child restraint and helmet use, speed reduction and drinking and driving reduction 2) police enforcement of the aforementioned road user behaviours 3) promoting sustainable urban transportation and improving the design of cities to meet the needs of pedestrians and not just cars; and 4) monitoring the impact of the city's progress, including road user behaviour, crashes, crash-related fatalities, and non-fatal injuries.

Twenty cities submitted comprehensive, multi-sectorial proposals addressing the burden of road traffic fatalities and injuries; ten cities were selected to participate in the Bloomberg Philanthropies Initiative for Global Road Safety. They include: Accra, Ghana; Addis Ababa, Ethiopia; Bandung, Indonesia; Bangkok, Thailand; Bogota, Colombia; Fortaleza, Brazil; Ho Chi Minh City, Vietnam; Mumbai, India; Sao Paulo, Brazil; and Shanghai, China. All key municipal stakeholders – health, police, transport, urban planning, and the Mayor's office – are actively engaged in implementing road safety interventions.

Bloomberg Philanthropies is providing cities with technical support from the world's leading road safety experts to implement their plans, with the expectation that city governments will commit resources to address road safety. Additionally, Bloomberg Philanthropies is funding three dedicated staff to work within each city government on road safety issues to ensure sustainability of the program. In the 18 months since cities have been engaged, we have seen outstanding commitments to address road traffic fatalities in the 10 cities participating in the Bloomberg Initiative for Road Safety. Select highlights include:

Bangkok, Thailand: Committed resources to develop and run a hard-hitting drinking and driving television campaign in April 2016, which was followed by strong police enforcement.

Bogota, Colombia: More than 100 miles of high-risk roads have been assessed and safety recommendations provided to the city for implementation.

Fortaleza, Brazil: Redesigned several intersections and sidewalks to improve pedestrian safety.

Ho Chi Minh City, Vietnam: Provided detailed design and safety recommendations to Ho Chi Minh City's Bus Rapid Transit (BRT) implementing agency. The safety recommendations will support the 18-mile BRT and 50 miles of connecting corridors running through the city.

Sao Paulo, Brazil: Redesigning several neighbourhoods to improve pedestrian safety and reduced speed limits to 40 km (25 miles) per hour.

Promoting vehicle safety

Vehicle safety plays a significant role in preventing and reducing road traffic fatalities. Given rapid motorisation globally, lives can be saved through improved vehicle safety technology and meeting minimum safety features developed by the United Nation's World Forum for the

Harmonization of Vehicle Regulations, such as airbags, seat-belt anchorages, electronic stability control and anti-lock braking systems (Global NCAP, 2015).

Bloomberg Philanthropies is supporting crash-testing of popular vehicles in Latin America, India and Asia; publishing test results so consumers can make informed decisions when purchasing a vehicle; and calling out car manufacturers who do not meet UN crash standards. Governments play a critical role in regulating vehicle safety standards, and many low- and middle-income countries lack these regulations (WHO, 2015). Since 2015, Bloomberg Philanthropies has supported crash-testing of 17 cars, some receiving 0 stars, the worst safety rating. Increasing awareness, advocating for strong regulations and holding car manufacturers accountable will help assure consumers can purchase safe vehicles regardless of where they live.

Road traffic deaths represent a public health epidemic. This global killer is beginning to receive well-deserved attention.

Bloomberg Philanthropies is committed to maintaining long overdue focused attention on the issue by applying established evidence to address the millions of preventable deaths and injuries each year through continued support to local, national and global efforts.

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The critical role of data, education and enforcement in road safety

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Introduction

As described by the World Health Organization (WHO) in the May 2016 special issue of this journal, the 2015 Global Status Report on Road Safety; the death toll on the world's roadways was 1.25 million per year (Peden et al, 2016).

While increased accessibility to motorised transportation may benefit countries, for many this boon has come with challenges for infrastructure, education, or enforcement. Leaving roadways in disarray where the largest vehicle often wins the ability to move first, usually ends with tragic and life altering crashes.

The WHO estimates that “3,400 people die on road[s] every day,” (UN, 2016) with “human error account[ing] for over 90 percent of [these] accidents.” (Olarie, 2011). It is time for the road safety community to change the narrative of these incidences by not referring to them as ‘accidents’ and to begin to recognise these crashes are preventable by modifying human behaviour (as well as other interventions).

When death or serious injury occurs on the roadways, its impact is far-reaching. Victims may die or suffer serious injuries requiring expensive hospital stays and lost wages, not to mention the emotional costs attached to these traffic crashes. For victims, these losses can send them and their families into an economic spiral, from which they may not be able to recover.

As countries' economies grow and the accessibility of motorised modes of transportation increases, law enforcement can play a key role in educating the public about dangerous driving behaviours, such as drink driving, distracted driving, speeding, and failure to wear a seat belt. By establishing clear educational and enforcement policies, law enforcement can provide the public with the knowledge they need to be safe on the roadways and follow up with enforcement actions to modify driver behaviour.

By reducing the number of roadway crashes, commerce is able to progress, allowing goods and services to be delivered to markets and economies to grow. People's lives ultimately improve in a safe driving environment.

The importance of data

Data plays an important role in helping law enforcement identify road safety problems. Before agencies can begin to properly address their road safety issues, they need to identify what the problems are, where the crashes are happening, and where the most pressing traffic safety problems are located. Through analysis of data, law enforcement agencies are able to develop appropriate countermeasures and strategically utilise their often limited resources.

Collecting and analysing data requires time, money, and people. Additionally, no universal way of collecting road safety data currently exists, and many agencies lack the internal capabilities to gather or analyse data. All agencies should look at what, if any, data they are collecting and review how and why they are collecting it. Even a limited amount of data can provide an agency with a starting point for developing beneficial educational and enforcement programs. If agencies are not collecting data, they should work to develop a reporting system that allows them the ability to capture the necessary data they need to better develop necessary road safety programs.

Once an agency begins to collect and analyse data, it can begin to determine how to apply the information to solve its road safety problems. Solutions need to have data behind them so the community understands and buys in to the educational and enforcement strategies the agency implements. Without the support from the community and the data to support these actions, agencies will see limited results.

The importance of education and enforcement

For far too long, people put little value on roadway safety and traffic enforcement. The reality is that traffic crashes have a great impact on communities as roadways are used by all individuals—pedestrians, bicyclists, motorcycles, cars and heavy vehicles.

The public has accepted that people dying on roadways is inevitable and assume it is part of doing business, which has created a culture of complacency. This culture of complacency is unacceptable, and it is up to law enforcement to change people's behaviours through education and enforcement (Bolton, 2008). The ultimate goal of enforcement and education is getting road users to take responsibility for their behaviour, thereby creating a safe road environment with reduced fatal and injury crashes. When combined, education and enforcement are highly effective methods to change driver behaviour.

Education

Through education and enforcement, law enforcement agencies can change the narrative and help their communities understand traffic safety is a priority, and this objective includes their safety, health, and economic stability.

One way law enforcement can modify driver behaviour is through public awareness campaigns. These campaigns can include a mixture of communication methods – mail, social media, newspapers, advertising, public forums, the media, or other localised means. Through these campaigns, coupled with the road safety data collected, law enforcement can educate community members about what they are doing, why they are doing it, and the role the community plays in making the roadways safe (Bolton, 2009).

Engaging other partners will also increase law enforcement's reach when conducting awareness efforts. These partnerships help to spread awareness messages, as well as reach audiences not accessed through some traditional outreach methods.

Once roadway users have been educated and provided with the opportunity to modify their behaviour, it is important to follow up with enforcement.

Enforcement

A robust enforcement program is a vital part of a healthy community and an effective tool to change driver behaviour. There are several ways in which law enforcement can effectively change driver behaviour: general deterrence and specific deterrence. A balanced combination of these two methods can have an impact on road users' behaviour.

General deterrence is a way of getting individuals to voluntarily comply because they perceive law enforcement is present and the risk of being caught is sufficient to deter. Specific deterrence is the actual legal punishment of an individual. (European Commission, 2016). Through an agency's educational efforts, the community should be made aware of the pervasive risk of enforcement activities taking place. Including enforcement into the efforts will help change behaviour and provide the voluntary compliance law enforcement is looking to achieve.

When conducting educational and enforcement efforts, it is important that they be goal-driven. This will allow the community and law enforcement to see the progress being made in improving roadway safety.

Finally, law enforcement agencies need to constantly evaluate what educational and enforcement activities they are doing with updated data, analysis, and input from the community and make the necessary modifications to their strategies and tactics to meet their goals.

Officer training and safety

(The authors would like to acknowledge Samuel Capogrossi, Project Manager, International Association of Chiefs of Police for contributing to the Officer training and safety section of this article)

All enforcement agencies should provide their officers with the education and training they need to conduct a roadway stop, and in doing so, maintain the professionalism of the organisation and ensure their own safety. To accomplish this, it is imperative that all road safety agencies develop policies and procedures for their road safety units.

The policies provide officers with the necessary instructions for how and when the enforcement action should be conducted. The rules and regulations also provide the department with the ability to ensure officers are working and conducting road safety activities within an appropriate and safe framework. Policies also provide agencies with the ability to dismiss or reprimand officers should it be revealed they are not following department policies.

Operational considerations

When training officers, it is important for agencies to consider the following operational considerations:

Communication: Officers must have the ability to communicate both location and motor vehicle stop details. The agency should always know the particulars of the motor vehicle stop.

Roadway considerations: Officers should know the roadways they are monitoring; for example, what type of roadway it is, and whether or not there are available shoulders, lane designation markings, construction zones, speed zones, intersections, roadway elevation, inclines, and declines.

Enforcement vehicle location: Officers should be aware of the location of the stop in relation to the flow of traffic, as well as the placement of the enforcement vehicle relative to the suspect vehicle. Is there an ability for oncoming traffic to take appropriate corrective actions to minimise dangers for collisions or bottlenecks at the traffic stop location?

Officer approach: The officer's approach to the vehicle depends on location, communication, and roadway considerations. Considerations need to be made for a passenger- or driver-side approach, as well as the number of occupants.

Environmental awareness: Officers should always consider location, traffic volume, and occupant activity, keeping in mind they may not be able to get back to the cruisers. Officers should therefore attempt to quickly become aware of the natural surroundings and the availability for cover and/or concealment, should the traffic stop turn into a dangerous situation.

Time of day: Oncoming traffic may have difficulties seeing a motor vehicle stop during dusk and dawn.

Vehicle lighting: Officers should ensure there is appropriate visibility for any oncoming traffic.

Finally, to engrain road safety into an agency's culture, the agency head must lead by example and place value and importance on safety, both on the roadway and in the department. This means explaining to officers why it is important to conduct road safety enforcement and holding the commanders accountable for the effective implementation of policies and procedures associated with the developed road safety strategy of the agency.

Member road safety programs

Developing road safety awareness programs and resources for law enforcement agencies to use has been a hallmark of the programs and services of the International Association of Chiefs of Police (IACP) throughout the association's 123 years. As an organization, IACP is committed to making roadways safe around the world.

The IACP has a global reach with more than 26,000 members representing 131 countries worldwide. Two of its member countries are Brazil, with the Federal Highway Police, and Canada, with the Ontario Provincial Police. These two agencies have implemented a variety of programs to improve safety on their countries' roadways.

Federal Highway Police (PRF), Brazil

(The authors would like to acknowledge the Federal Highway Police, Brazil, for contributing to the Member road safety programs section of this article).

The Federal Highway Police in Brazil, Polícia Rodoviária Federal (PRF), uses a number of approaches to improve road safety.

Statistics Control Project (SCP)

This program trains law enforcement officers on how to use statistical tools such as Business Intelligence and Microsoft Excel to build their own plans and use these tools to help them make better decisions not only about operations involving law enforcement, but also about managing their own responsibilities. The main goal is to show them how important it is to use data to find the main causes and "hot spots" where the most crashes and fatalities occur. With this information, officers are able to make better use of the resources available to them to reduce traffic violence.

Problem:	High number of road crashes and fatalities.
Solution:	Combining statistics knowledge and preventive actions.
Implementation:	Training all managers in the country.
Benefits:	Improved planning, use of resources, and a reduction of crash and fatality rates.

Traffic Education and Citizenship

The Traffic Education and Citizenship program (road film and lecture theatre road truck) is aimed at raising awareness and modifying behaviour to promote safe roadway practices. The traffic education portion of the program focuses on preventing and reducing crashes, improving health, preserving the environment, and promoting citizenship. The program is also designed to change attitudes through interventions with traffic sectors: drivers, passengers, and pedestrians. The activities target changing behaviours by presenting the risks associated with transportation and encourages the adoption of individual choices that can protect life or reduce the risk of injuries caused by traffic crashes.

Problem:	Inappropriate behaviour by drivers while in a vehicle.
Solution:	Increase road users' awareness of behaviours.
Implementation:	Through targeted activities – display of movies targeted at different audiences in a truck adapted to be a movie theatre over wheels.
Benefits:	Increased awareness of traffic safety and behaviour change.

Thematic Student Festival Traffic – TSFT (FETRAN)

The Thematic Student Festival Traffic (TSFT) is a project that uses educational activities about traffic situations in everyday school life. In TSFT (FETRAN), students and teachers produce works on traffic issues in the form of plays, models, poetry, dance, music, and other methods to promote educational and cultural diversity. The developed materials are presented in the Thematic Exhibition of Traffic and Transit Theme Festival with the aim of integrating the PRF, school, and society.

Problem:	Need to implement a culture of safe transit.
Solution:	Reach young students.
Implemented:	Through visits and courses in schools and society.
Benefits:	Formation of ethical citizens, able to reflect on the context in which they live and act as change agents for the construction of safer traffic.

Integrated Operations

Operation Rodovida Integrated is a major government effort involving the Federal Government, states, and municipalities to reduce crashes and traffic fatalities. Simultaneous and joint activities at predefined locations and times are designed to increase the presence and availability of government agencies in providing road safety, comfort, and fluidity.

Problem:	Lack of standardisation of inspection between the levels of government.
Solution:	Collaborative actions in enforcement activities.
Implementation:	Preparatory meetings at the State Department, involving the Ministries of Justice, Cities, Transport, Health and the Secretariat of Communication for the President, combined within the respective axes of competence and performance, in order to join forces in combating violence in traffic.
Benefits:	Approximation of Traffic Inspection agencies with consequent reduction of crashes.

Ontario Provincial Police (OPP), Canada

(The authors would like to acknowledge the Ontario Provincial Police, Canada, for contributing to the Member road safety programs section of this article).

The Ontario Provincial Police (OPP) Highway Safety Division utilises a number of innovative strategies toward road safety including the use of specialised Traffic Incident Management and Efficiency Teams and Unmanned Aerial Systems.

Traffic Incident Management and Efficiency (TIME)

The mandate of the Traffic Incident Management and Efficiency (TIME) Teams is to provide rapid clearance and investigative excellence for Benchmark Collisions in

the Highway Safety Division (HSD) – Greater Toronto Area (GTA). Benchmark Collisions include fatal and life-altering crashes, collisions involving government automobiles, suspect apprehension pursuits, and the Special Investigations Unit, as well as complex investigations involving commercial motor vehicles. These crashes typically result in highway closures to major transportation conduits throughout the GTA. Some estimates put the cost of a major highway closure at \$600,000 per hour (Transport Canada, 2007). The TIME teams are a collaborative approach to traffic incident management, providing support to all OPP detachments within the GTA over approximately 3,000 kilometres of highway.

Problem:	Need to provide rapid clearance and investigative excellence for benchmark collisions.
Solution:	Establish collaborative teams (TIME Teams) to deploy to collision scenes.
Implementation:	Four TIME teams covering the GTA on a 24/7 basis to ensure an immediate response, each consisting of 5–7 members deployed throughout the GTA, ensuring the appropriate investigative specialties are available at all times. The teams utilise Robotic Total Stations and Unmanned Aerial Systems.
Benefits:	Efficient evidence capture and clearance of roadways; reduced time needed for investigations while maintaining excellence, resulting in rapid clearance and related cost-savings.

A Robotic Total Station (RTS) is an electronic/optical instrument integrated with an electronic distance meter to read slope distances from the instrument to a particular point. An RTS allows the operator to control the instrument from a distance via remote control. This feature eliminates the need for an assistant officer as the operator holds the reflector and controls the total station from the observed point.

An Unmanned Aerial System (UAS) is available to teams for mapping. The UAS goes beyond the RTS, utilising aerial photography and video to create an ortho-mosaic aerial image. The system provides a photo “grid-map” of the scene. The software also allows for the traffic crash reconstructionist to manipulate both 2-D and 3-D images of the scene from various vantage points. The accuracy of the UAS is one centimetre per pixel and remarkably close to the accuracy of an RTS, which takes approximately two hours to map a collision scene. The UAS reduces this time to approximately 10 minutes. When deployed, the UAS greatly contributes to rapid clearance while maintaining investigative excellence.

Conclusion

Road safety continues to be a significant concern for all regions of the world, but, with the inclusion of law enforcement, road users can begin to identify the role they play in reducing road crashes. Through the use of data, education, and enforcement, road users’ behaviours will change, leading to safer roads. This paper provides guidance on best practice to achieve the desired behaviour change.

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Road safety made personal, local and real: the Global Alliance of NGOs for Road Safety - an umbrella for nongovernmental organisations

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Abstract

Nongovernmental Organisations (NGOs) are a key part of the road safety equation: They make the issue personal, local and real. NGOs are instrumental in generating a demand from the public and from governments for safer roads, and when they base their interventions on evidence about what works, they can contribute in significant ways to saving lives. Strong NGO participation is essential to achieve the global targets for increasing road safety and reducing road fatalities.

With 170-plus member NGOs active in more than 80 countries, the Global Alliance of NGOs for Road Safety (the Alliance) was founded in response to demand from NGOs worldwide for a forum where they could share best practices and collectively advocate for road safety and the rights of victims of road traffic injury.

The Alliance provides concise information about the activities of NGOs to non-NGO actors, including governments, foundations, intergovernmental agencies, the media, and other stakeholders with an interest in road safety. The Alliance also coordinate and mobilise activities aligned with the Decade of Action 2011–2020 and the Sustainable Development Goals. This involves the Global Meeting of Nongovernmental Organizations Advocating for Road Safety and Road Victims, which takes place every two years; regular communications and outreach; and mobilisation of ongoing responses to the Global Plan for Road Safety.

Around the world, NGOs are acting as advocates and implementers of road safety programs and activities. NGOs are often set up by citizens in response to a need they see around them. NGOs fill the gap in government programmes, and can influence decision making.

The Global Alliance and its member NGOs are at the forefront of the global effort to save lives on the roads.

Introduction

Each year, more than 1.2 million people die on the world's roads, and tens of millions are seriously injured. Road traffic crashes are currently the number one killer of young people aged 15–29. As countries develop and acquire ever more motorised vehicles, road traffic crashes are projected to become the seventh leading cause of death globally by 2030 (WHO, 2015).

Alongside the devastation that road traffic crashes impose on victims' families and loved ones, they also take a tremendous toll on the economy. Each year, developing countries lose up to 5% of their gross domestic product (GDP) (WHO, 2015) owing to medical costs, productivity losses, and other expenses resulting from deaths and injuries on the road, which is more than most of them receive in development aid.

These consequences are preventable, and NGOs play a critical role in addressing these issues and reducing the impact of road traffic crashes around the world.

History: the road to the Alliance

In May 2009 in Brussels, Belgium, the World Health Organization (WHO) brought together for the first time 70 NGOs working on road safety in 40 countries. The mission was to discuss how NGOs can help advance the road safety agenda, and the outcome was the Brussels Declaration, which is the compilation of 33 recommendations to governments that formed the framework for the Decade of Action 2011–2020.

This first meeting showcased civil society's importance in reaching the Decade of Action goals. In 2010, WHO asked nine United Nations Road Safety Collaboration (UNRSC) members to explore the possibility of an alliance of road safety NGOs. The group conducted a survey among road safety NGOs where 89% indicated that a lead NGO-coordinating body would be useful. WHO subsequently created a steering committee to move forward with the idea. The founding assembly took place in 2012, and the new alliance was named the Global Alliance of NGOs for Road Safety. Soon thereafter, the organisation's bylaws and Strategic Plan for 2014–2018 were established.

The Alliance is governed by a five-person board of directors and recruited its first staff in late 2014. The Alliance is registered as a tax-exempt organisation with a seat in Zurich, Switzerland, under Swiss Civil Code article 60. The Alliance's highest authority is the General Assembly, where each NGO Alliance member has one vote. The General Assembly is held every two years.

What does a road safety NGO look like?

As of May 2016, the Alliance has a total of 178 members in 81 countries. Table 1 shows the geographical distribution of the members and it can be seen that most members are located in Europe, followed by Africa. Fewest members are found in Eastern Mediterranean region.

The Alliance have most members in India, Kenya and Nigeria. However, the majority of Alliance member NGOs (60%) are the only road safety NGO operating in their country. Late in 2015, the Alliance conducted a baseline survey to better understand the member base and its characteristics. Although the majority of road safety NGOs may be the only civil society road safety group in their country, the majority are affiliated across regional networks or with a specific interest group such as victim groups or children injury prevention groups. NGOs are founded in response to a need in their country; this could be an urge to do something about safe school routes, bad lighting at night, or seeking justice for the loss of a loved one. Alliance member NGOs are familiar with key road safety, health and development frameworks, such as the Global Plan and Sustainable Development Goals. For planning purposes, they use data from sources such as the WHO's Global Status Reports and national databases. NGOs have at least one staff member, although 27% are run by volunteers only. Funding is a major concern: 88% cite insufficient financial resources as their biggest challenge and only 14.1% of member NGOs have two or more years of funding available to cover operations.

The main funding source for 70.4% of Alliance members is private sector donations. Other significant sources of funding for Alliance members include international donors (35.2%), fees for products and services (29.6%) and local government contributions (26.8%).

Alliance role in supporting NGOs

The Alliance recruits members from all corners of the world and receives several applications per month. Applicants undergo a thorough assessment to ensure they are registered NGOs, active in the field of road safety, implementing activities, willing to share their ideas, and a proactive part of the road safety movement.

To support the members, the Alliance work in three areas: networking and sharing, advocacy, and capacity building. Examples of our work in these areas follow.

Networking and sharing

Given its central position, the Alliance plays a unique role in providing timely information to all members through different channels, including personal outreach, websites, newsletters, and social media.

The Alliance provides information about global campaigns and events such as United Nations Road Safety Week, launch of the Global Status Report, #SaveKidsLives, and the World Day of Remembrance for Road Traffic Victims. Also grant opportunities, the latest research on road safety, and best practices are shared frequently. New Alliance members are introduced to the community to ensure that NGOs working in the same field connect and collaborate. The website has recently been updated, and each member has a profile page. In addition, the Alliance issues regular e-newsletters to more than 1100 partners and advocates working in road safety around the world. In 2015, the newsletters included important updates on the Second Global High-Level Conference on Road Safety in Brazil and served as one of the event's central information sources.

Global meetings

Among other activities, every two years the Alliance produces a global meeting of road safety NGOs in collaboration with the WHO. To date these meetings have been held in Belgium, the United States, Turkey and Morocco. The Fourth Global Meeting of NGOs Advocating for Road Safety and Road Victims was hosted by the Moroccan National Committee for Traffic Accident Prevention, in Marrakech, Morocco. The meeting was attended by 201 delegates from more than 52 countries. The meeting featured a poster exhibition for member NGOs to share best practices; panel discussions on key road safety topics with experts from the World Bank, WHO, and other organisations; two capacity-building workshops on fundraising, project monitoring and evaluation for member NGOs; and the second General Assembly for members to vote on bylaws and elect the Alliance Board of Directors.

Advocacy

In collaboration with FIA Foundation, the Alliance co-launched the official UN Road Safety Week campaign, #SaveKidsLives, in November 2014. The #SaveKidsLives campaign is an international initiative mobilising hundreds of NGOs, governments, and other road safety advocates to educate their communities about the unacceptable number

Table 1. Geographic distribution of Alliance members

Africa	Americas	Eastern Mediterranean	Europe	South and East Asia	Western Pacific
25%	21%	6%	30%	9%	8%

Note: Regional distribution according to WHO's geographical definition

of young lives affected by road traffic crashes. Under the #SaveKidsLives campaign, local advocates helped to gather hundreds of thousands of signatures for the Child Declaration on Road Safety, which, from the perspective of a child, urges world leaders to take road safety seriously and make it a priority in the post-2015 Sustainable Development Agenda. The Alliance was instrumental in collecting the one million signatures in support of the Child Declaration that were handed over to global leaders at the Second Global High-level Conference in Road Safety, in Brazil in November 2015.

World Day of Remembrance

The annual World Day of Remembrance for Road Traffic Victims, established by the United Nations, is commemorated every year in November. The Alliance connects members around the world with international awareness activities and media materials so that they can promote the event in their countries, thereby raising awareness about the tragic toll that road traffic crashes take on loved ones and families.

Capacity building

NGOs around the world respond to the global road safety crises with different levels of human and financial resources, organisational capacities, and strengths. With the establishment of a permanent Secretariat in September 2014, the Alliance was able to provide direct assistance and technical support to member NGOs. The Alliance answers inquiries from hundreds of NGOs and connects them to services and partners that help them develop their programs and organisational capacity.

To help the Alliance support members in reaching their fullest potential, the Alliance launched the Alliance Empowerment Program during an NGO rally leading up to the Second Global High-Level Conference on Road Safety in Brasilia, Brazil in November 2015.

The Alliance Empowerment Program conducts a range of capacity-building activities and training and mentor arrangements for members; such as webinars on risk areas, communication, advocacy, fundraising, and monitoring and evaluation.

Affiliations and partnerships

The founding of the Alliance was driven by the World Health Organization, who also served as secretariat until August 2014. The WHO also funded the first three Global Meetings and remains a close ally and friend of the Alliance; their advice and views are sought out on a regular basis.

In addition, the Global Road Safety Facility hosted by the World Bank is a long-time funder, supporter and friend. The Alliance and the FIA Foundation have partnered on numerous occasions, especially on UN Road Safety Week and mobilisation of the civil society. The Global Fund

for Road Safety (managed by the FIA Foundation and the WHO) is currently providing funding for the Alliance's implementation of its strategic plan and FedEx is providing funding for networking, sharing and capacity building efforts.

Moving forward

Alliance member NGOs are often set up by everyday citizens responding to needs they see around them. The Alliance support global road safety NGOs to fill government gaps and influence decision making through advocacy, awareness and education. The Alliance and its members play a vital role in the growing worldwide movement to reduce the devastating effects of traffic injuries. With interventions based on evidence for what works, Alliance member NGOs help save lives and the Alliance plays a unique, central role in mobilising and connecting NGOs and road safety stakeholders.

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Maximising travel on 3-star or better roads: Safer roads and safer speeds to deliver the 2020 UN road safety targets

by Rob McInerney FACRS

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Introduction

Death is currently built into our road system and our road designs. Road crashes are the biggest killer of young people, and typically cost 3-5% of GDP in most countries worldwide. For reasons of historical road design standards, the lack of upkeep with the evolution of vehicle speeds over time, and increasing budget constraints, many existing roads are designed for the community in a way that tolerates crashes that kill and injure road users. The responsibility is passed onto road users to cope with and navigate the built-in risks in the road system.

The inconvenient truth of the global road safety crisis

Whether in Australia, New Zealand, Ethiopia, South Africa, Brazil or the UK the predominant response to the tragedy of road crashes by politicians and engineers alike is that the fault lies with the drivers or pedestrians. This common belief provides an excuse for inaction or a lack of understanding in the profession of how critical road design and maintenance are for preventing a crash occurring in the first place or managing the severity of the crash if one occurs. While road users must take a shared responsibility for road safety, the safe system approach being adopted worldwide now starts to place a high degree of accountability and opportunity on the system designers to save lives and reduce serious injuries.

Like their colleagues in the medical profession, engineering professionals around the world operate to a code of ethics that typically refer to valuing life and 'doing no harm'. For example:

- Australia – “Practise engineering to foster the health, safety and wellbeing of the community and the environment”;
- UK – “Respect for life, law and the public good”; “Minimise and justify any adverse effect on society” and “hold paramount the health and safety of others”;
- USA - “Hold paramount the safety, health and welfare of the public”.

With these guiding principles for the engineering professional, the current management of road networks which results in the death and injury of an estimated 30-50 million people a year must be challenged on ethical

grounds. The elevation of speed and travel time savings ahead of safety considerations must be challenged. The acceptance of the existing condition of road networks and under-investment in proven engineering measures must also be challenged.

In essence the road manager and engineer, in accordance with their respective code of ethics, must question why safe system principles should not be applied, and seek the resources to implement safe system engineering solutions.

With the United Nations Sustainable Development Goal (SDG) target to halve deaths and injuries from road traffic accidents by 2020, it is time to challenge the status quo and seek a large step-change in the response and attitude of the engineering profession to the global road safety crisis.

Road authorities and road engineers worldwide must take the lead, and challenge current road design standards, road maintenance standards, road budgets, project financing and prioritisation processes to elevate the protection of human life in line with the rail and air transport sectors. We must put the past behind us, accept where we are today and strive to create a world free of high-risk roads together.

The fundamentals of physics and road crashes

The forgotten formula of road design is $E_k = \frac{1}{2} m v^2$. The fundamentals of physics as they relate to road design safety are often absent from an engineering degree course and in many cases, road design standards. While detailed formulas exist for curve transitions, pavement strength or bridge design the interaction of humans in different vehicles and different speeds can be overlooked. The pavement strength of a road is well managed while the energy mismatch between road users on the road surface is not routinely measured or managed.

Table 1 provides a demonstration of the different philosophical approach to attributing the causes of crashes that kill and injure. One can look at crash causes from a behavioural and an engineering perspective.

That there is an engineering cause for every key crash type highlights that whether or not behaviour also played a role in causing the crash, engineering solutions exist. When taking into account the total social and economic costs to the community the engineering solutions are often cost effective. The causes of road death and injury can be

eliminated from the system and the benefits will be greater than the costs.

The safety gaps in the global road network

All of the road attributes in the international Road Assessment Programme (iRAP) star rating models impact the likelihood or severity of a crash. They provide partial or total contribution to safe system outcomes for that particular circumstance, speed, road user and crash type. As an indication of how the iRAP data can be used to explore the level of compliance of current road designs with safe system principles, an analysis of iRAP assessments on

170,807km of roads in 33 countries undertaken during 2013 and 2014 is provided in Figure 1.

These data highlight the built-in risk of the world's road networks and the underlying cause of major crashes that result in the death and injury of children and adults.

The potential for infrastructure to save lives

The potential for economically viable road infrastructure investment to eliminate death and injury is demonstrated in Figure 2. Rather than focussing on the road user error the analysis highlights the potential for cost effective

Table 1. The cause of road fatalities and injuries

Crash Type	Behavioural Cause	Engineering Cause
Head-on	Road user poor judgement or lane departure	Undivided high-speed road
Run-off road	Distraction, fatigue or speed on a curve	Road alignment and unprotected roadside hazards
Intersection crash	Incorrect yielding	Conflict speeds too high and insufficient time or space separation
Pedestrian crash	Poor crossing behaviour or walking on the road	No footpath, safe crossing point or speeds too high for function of road

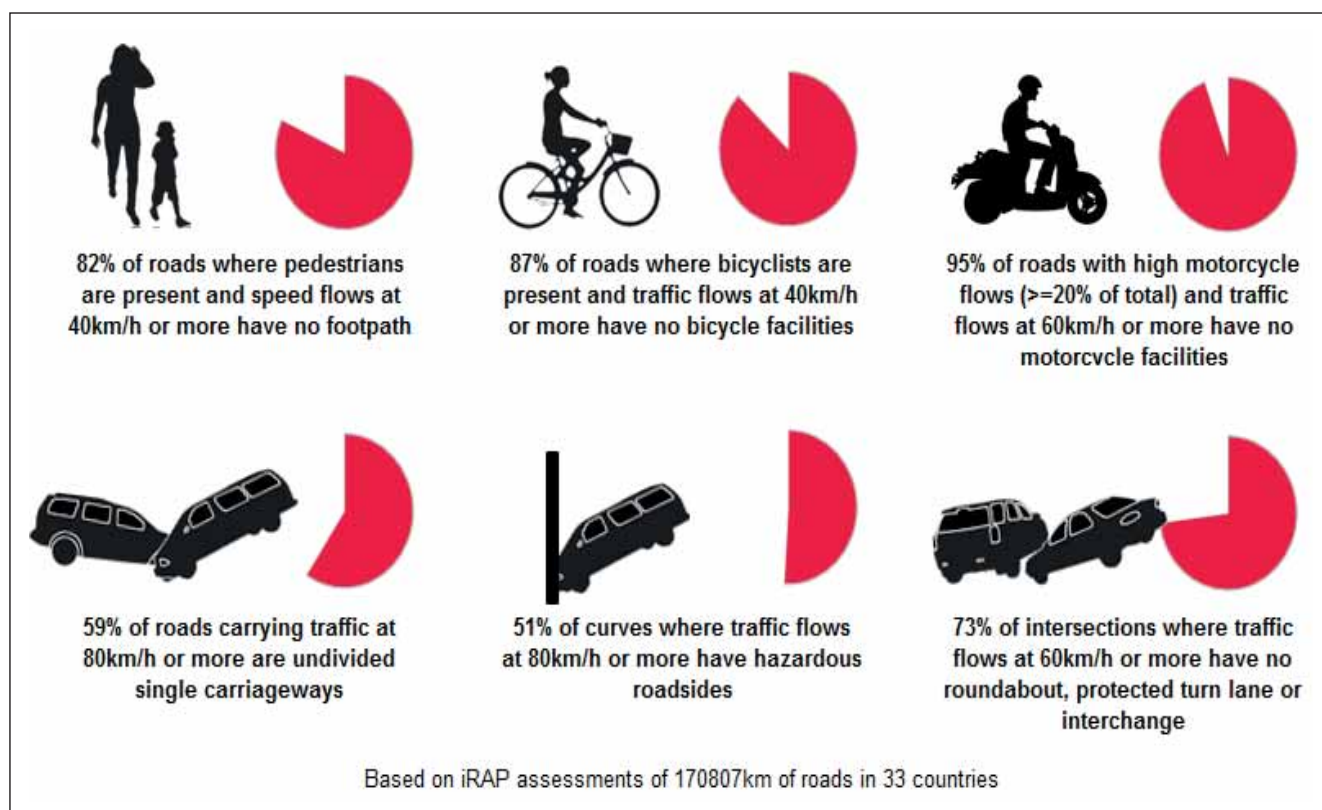


Figure 1. Safe System performance of the world's road networks

engineering treatments to eliminate fatalities and serious injuries associated with the major crash types. Proven engineering treatments can typically more than halve the death rate on targeted high risk roads.

The individual treatments to save lives are well-established and the evidence base is extensive. Examples of high return investment plans from iRAP assessments around the world are shown in Table 2.

Opportunities for policy and engineering leadership

Some immediate areas for policy and engineering leadership should include a revision of road design standards worldwide to standards that account for the safe system principles, the known limited tolerance of the

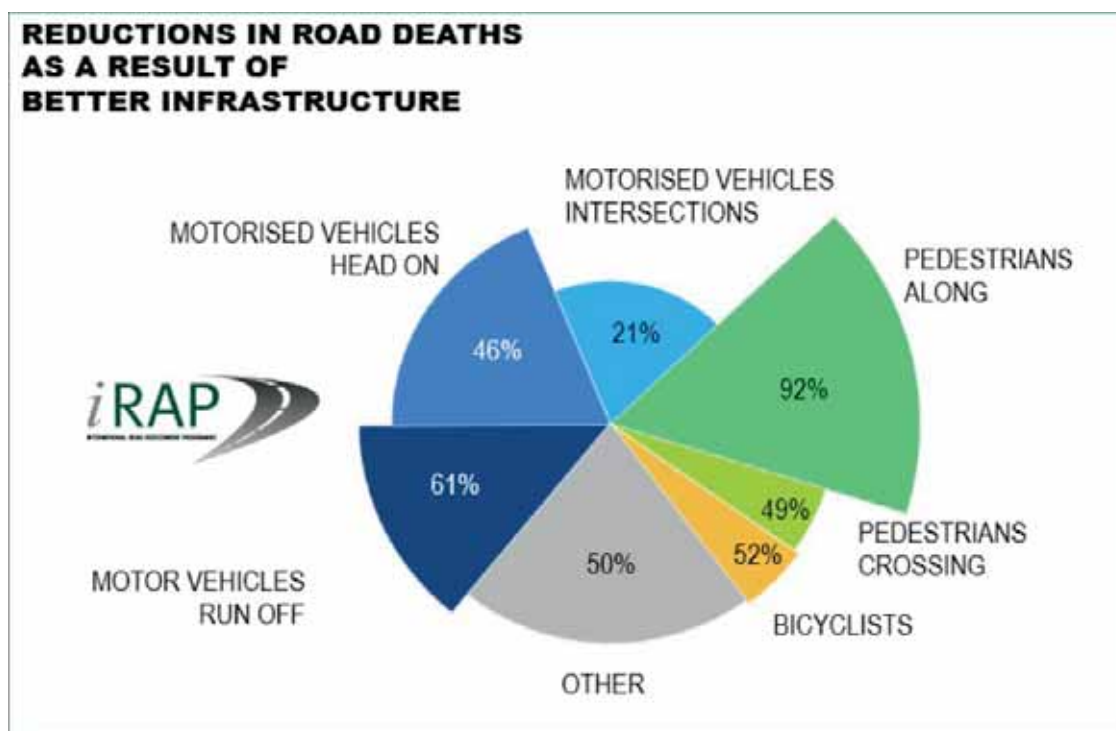


Figure 2. Fatality reduction potential of safer roads

Table 2. High return engineering countermeasures from around the world

Country	Treatment	Length	Deaths & Serious Injuries Saved (20yr)	Economic Benefit (US\$)	BCR
Australia	Protected turning lanes	1,782 sites	1,340	\$ 500 million	7
India	Footpaths	1,843 km	10,000	\$135 million	4
Mexico	Roadside Barriers	14,500 km	155,000	\$11,600 million	5
Egypt	2+1 design with median barrier	493 km	8,400	\$210 million	6
Uganda	Shoulder widening	1,366 km	18,090	\$340 million	24
Netherlands	Rumble strips	4,569 km	1,125	\$400 million	7
Brazil	Pedestrian Fencing	108 km	3,590	\$40 million	29

human body to injury, and the limited ability of vehicles to avoid and manage impact. In simple terms:

- Design standards should not allow an undivided high-speed road separated by a thin white line to be built. Central barriers or at a minimum wide centreline painted medians should be adopted.
- Design standards should not allow steep embankments or large rigid objects to remain unprotected along the roadsides of high-speed roads.
- Design standards must manage the interaction of road users at intersections and separate or manage the speed of conflicting travel paths wherever possible.
- Design standards should not allow high-speeds in urban areas and villages without footpaths, safe pedestrian crossings, cycle lanes and/or the management of vehicle speeds.

While Australian and New Zealand practice may capture these basic needs for safety they are often only applied on higher volume roads. Our historical road system retains many of these built-in risks. Furthermore, worldwide many brand new roads are still being built with these known, fundamental failures in road design. In addition, when faced with tight project budgets and timelines it is often the road safety elements that are omitted without consideration of the likely death and injury that will result. New roads are opened without line markings, without separation, without barriers and without footpaths or crossings. The tragic consequences of building such high risk roads are then left to the communities to suffer while the project teams move on to the next project.

Global support for policy leadership

The United Nations SDG target has provided the foundation for a global change in attitudes and actions for road safety.

The Ministerial Conference in Brazil in November 2015 united world leaders with a focus on action across all five pillars of the UN Decade of Action for Road Safety.

In the infrastructure area the World Bank and regional development banks reinforced their commitments to encouraging and financing safer road infrastructure. Ministers outlined their national actions to improve road safety from child safety in Sweden to urban transport infrastructure safety in Brazil. Zoleka Mandela provided a powerful and passionate call to action on all road safety priorities including infrastructure (Figure 3).

Organisations like the Fund for Global Health have established a 3-star coalition to build awareness, demand and support for minimum safety standards for all new road projects. With supporters including the Institute of Transportation Engineers, Insurance Institute for Highway Safety, American Academy for Pediatrics and the Association for Safe International Road Travel the coalition is building the support for the required change and commitment to stronger road safety action. With road deaths and injuries typically halved moving from 1-star to 2-star and halved again going from 2-star to 3-star, the potential to save lives with better specification of safety outcomes in road projects is clear (refer to the later section on the economics of 3-star or better roads).

The safe system work by leading countries around the world is providing a framework for engineers to challenge current practice and seek to eliminate death and injury from the world's roads. The OECD is leading an important global publication on safe system leadership and application that will be published in late 2016. This report will showcase safe system practice from leading countries like Sweden, Denmark, Netherlands and examples from Australia and New Zealand. The World Road Association (PIARC) has also consolidated global best practice into the PIARC Road Safety Manual that provides a living online resource for the world.



**“At least three star safety
on the highest risk roads
by 2020 – no excuse”**

Zoleka Mandela, Brazil 2015

Figure 3. Zoleka Mandela speaking at the Ministerial Summit in Brazil in 2015

Many simple changes in road design exist for countries to immediately implement in order to fast-track results in saving lives for all road users.

High-income Country Policy Leadership

- The Dutch Government was the first to adopt a no one or two-star road by 2020 policy.
- The Swedish Government measure the percentage of vehicle mileage on roads that meet EuroRAP four-star standard. The Government expect that 75% of travel on the Swedish national road network will achieve 3-stars or better by 2020 and approaching 100% by 2025.
- Highways England has adopted a target for 90% of travel to be on 3-star or better roads by 2020. This is linked to broader goals for 4 and 5-star motorways.
- The New Zealand Government has a target for 4-star Roads of National Significance (RONS) and recently adopted a review of design standards that ensure Roads of National Significance will be implemented with a minimum 4-star rating.
- The Bureau of Infrastructure, Transport and Regional Economics in Australia has proposed that all new roads should be 4+ stars and no road user group less than 3-star. The Tasmanian Government has set a target for the Midlands Highway to be 3-star standard. The Queensland Government has a target for 85% of travel on national highways to be 3-star or better by 2020.
- Performance tracking using risk mapping is active across Europe (EuroRAP) and the US (usRAP) and New Zealand (kiwiRAP). Example reports include the 2014 UK results and the 2012 New Zealand results.
- Benchmarking of the European road system was undertaken as part of the 2011 European Road Safety Atlas project supported by the EU.
- Toll road concessionaires in New Zealand and Chile have set 3 and 4-star targets for their infrastructure as part of a focus on customer service.
- Mining companies have assessed their road networks and immediately invested to bring the roads to minimum 3-star standards from a health and safety perspective implementing both economically viable treatments and those that provide minimum safety standards.
- The Ministry of Transport in China is rolling out ChinaRAP assessments to an expected 350,000km of roads as part of their Highway Safety Enhancement Project titled “highway safety to cherish life” that is accompanied by billion dollar investments to upgrade roads.
- The road authority in Mexico (SCT) has assessed over 60,000km of roads and has implemented targeted maintenance spending to reduce 1 and 2-star road sections by close to 20%.
- The MDB Road Safety Guidelines have identified road safety rating as one of the issues to be considered in all stages of a road project (Figure 4).
- The SLoCaT Results Framework (p23) developed to support achieving the proposed SDG target to halve road deaths includes an implementation measure to eliminate one or two star roads by 2030.
- The World Bank SSATP programme has developed the Managing Road Safety in Africa publication (Figure 4) that provides a framework for national lead agencies that “can develop a prioritised program of works towards achieving at least 3 star safety ratings for all road users” (p46).
- The ADB Sustainable Transport Appraisal Rating (Figure 4) integrates the star rating performance targets into their Sustainable Transport Appraisal Rating including the recommendation for minimum 4-star standards for pedestrians in linear settlements and minimum 4-star standards on roads carrying 50,000 vehicles or more.
- The World Bank and relevant state governments have applied minimum star rating standards as part of road projects in Karnataka, Assam, Gujarat and Kerala in India. The Gujarat Results Report includes the monitoring of the length of the corridor meeting the star rating target.
- The ADB has also applied a similar star rating approach in Shaanxi and Anhui in China. These projects captured the economic benefits of minimum 3-star roads that have now been built into the economic modelling and internal rates of return for loan projects.

Low and middle-income countries (LMIC) Policy Leadership

- The Malaysia Government is the first LMIC to set a star rating target with their commitment for 75% of travel on high volume roads to be 3-star or better by 2020.

The economics of safer road infrastructure

One fundamental question to ask in relation to road safety is whether the level of investment, across all pillars of action, is commensurate with the scale and estimated 3-5% of GDP cost of the problem.

The inconvenient truth is that our ability to blame the road user allows us to spread the accountability sufficiently thin

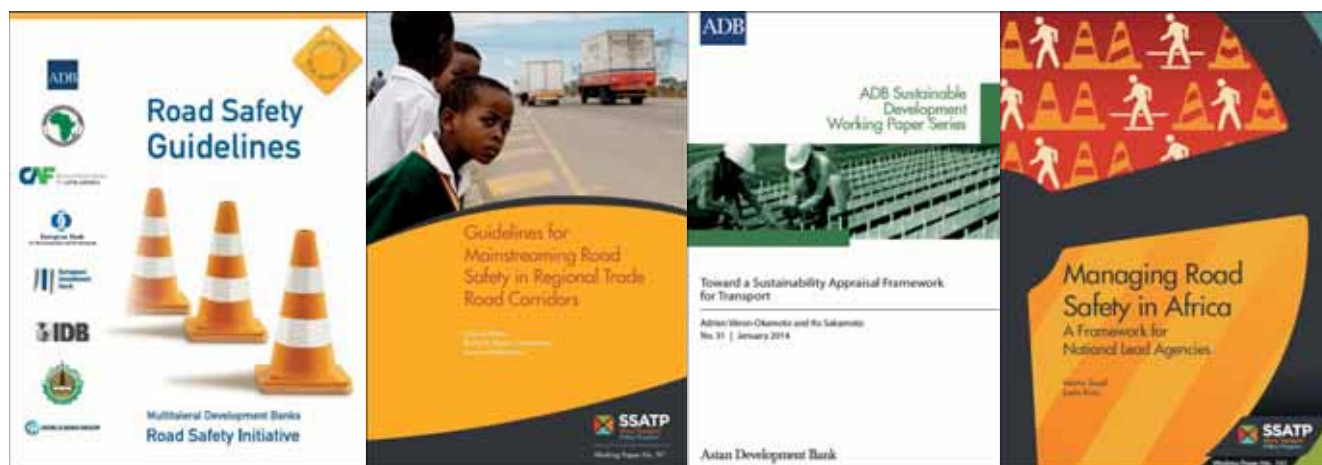


Figure 4. Example LMIC Road Safety Policy documents

that no one sector takes full accountability to eliminate death and injury from our roads. The airline industry would not tolerate such an approach, neither would the rail industry, the building industry, the mining industry and neither should the road industry.

The business case for safe system road infrastructure investment

Linked to the ethical, health and community benefits of road trauma reduction, the business case for investment in safe system outcomes is compelling. An analysis of iRAP assessments undertaken by road agencies worldwide was used to develop a global business case for road investment. The analysis suggests that a targeted investment of \$681 billion (or less than 0.1% of GDP per year for ten years) could save an estimated 40,000,000 deaths and serious injuries over 20 years with a return on investment of \$8 for every \$1 invested (Table 3). (iRAP, 2014a)

The key to the appropriate level of investment in road trauma reduction is to bridge the gap between those who benefit from reductions in road trauma (emergency services,

hospitals, health and welfare systems, insurers, business and Treasury) with those who hold the safe system solutions (road agencies, vehicle manufacturers, educators and police).

The potential for Social Impact Bonds, or Impact Investing products to provide the mechanism to close this gap are being actively explored worldwide. A pilot study is currently being undertaken by the FIA Foundation, iRAP, TAC, VicRoads, ARRB and the RACV in Victoria, Australia to develop a social impact bond calculator to measure the financial savings to all stakeholders from an investment in safer roads (McInerney et al, 2015). With success, the approach has the potential to mobilise the appropriate level of resources to address the road safety crisis and lift an enormous burden from health systems and individuals worldwide. This approach represents a win-win-win for all.

The economics of 3-star or better roads

The use of infrastructure star ratings is providing a positive

Table 3. The business case for safer roads

What could be achieved	Low Income	Lower-middle income	Upper-middle income	High Income	ALL
Improve highest risk 10% of roads	108,000 km	610,000 km	992,000 km	1,546,000 km	3,255,000 km
Build viable countermeasures	\$8 billion	\$61 billion	\$149 billion	\$464 billion	\$681 billion
Reduction in fatalities	384,000	1,483,000	1,528,000	283,000	3,678,000
Reduction in fatalities and serious injuries	4,224,000	16,313,000	16,808,000	3,113,000	40,458,000
Economic benefit	\$83 billion	\$663 billion	\$2,766 billion	\$2,202 billion	\$5,715 billion
Benefit cost ratio	11	11	19	5	8

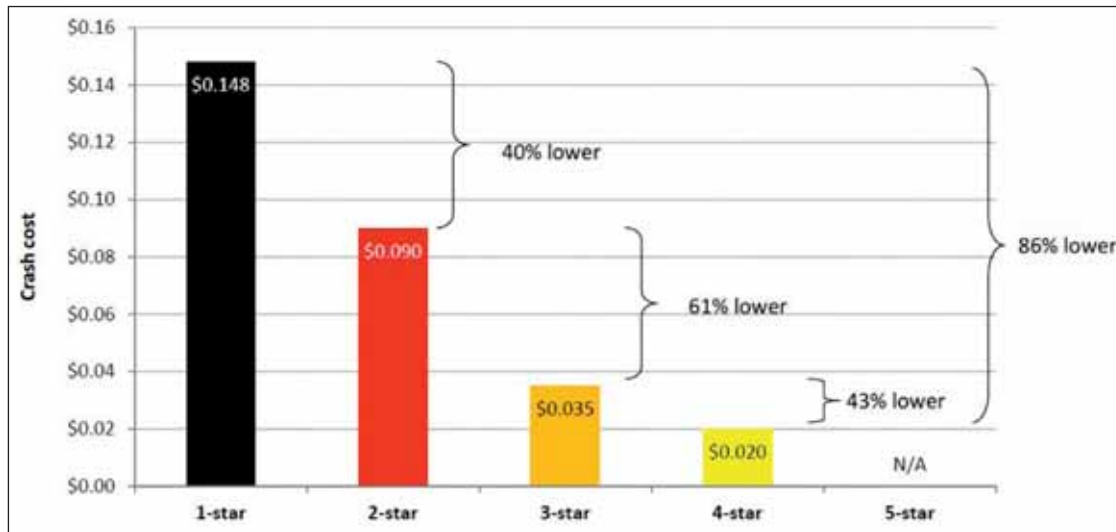


Figure 5: Relationship between star ratings and crash costs per kilometre travelled

stimulus for change in partnerships with government, development agencies and civil society worldwide as highlighted in the policy examples above. Understanding the economics of 3-star or better roads is also important to ensure investment is optimised.

Studies from around the world have consistently shown that fatal and serious injury crash costs are approximately halved for each incremental improvement in star rating (Figure 5). The investment focus of a road agency is then on maximising lives and serious injuries saved per dollar spent. This typically results in an investment plan that raises high volume roads to 4 or 5-star standard with engineering treatments and eliminating all other 1 and 2-star roads through a combination of speed management and lower-cost engineering improvements.

Targeting action on safer roads

The risk maps from New Zealand, Europe and the US highlight how actual deaths and injuries are concentrated on certain parts of the road network (Figure 6). Improving the safe system elements including infrastructure features and associated star ratings is a priority at these high risk locations.

Before and after star ratings

The before and after star ratings are now being increasingly used to help design teams (Figure 7), road funders and politicians measure and celebrate improvements in road infrastructure safety. Linked to the policy targets and specification of minimum star rating targets for new road

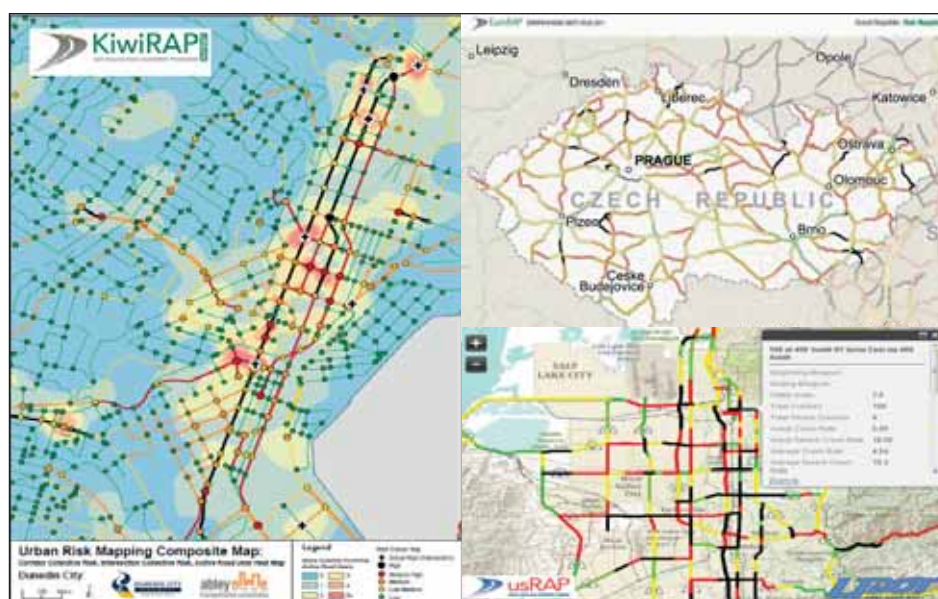


Figure 6: Urban and rural risk mapping examples from Europe, US and New Zealand

projects the design teams can immediately measure the performance of their design before construction. Politicians and project stakeholders can celebrate positive road safety improvements by ribbon-cutting the new 4 or 5-star roads.

Where crash data is available the monitoring of crashes before and after new safe system treatments are implemented is also important. This confirms the effectiveness of treatments and improves the evidence base upon which future investment decisions can be made.

Communicating success

The tragedy of road crashes will typically impact all members of the community at some stage in their life as they are either involved in a crash themselves or a friend or family member is directly impacted. Improvements to road safety should therefore be celebrated and shared with the public and demonstrate the positive contribution of a road agency, police agency, vehicle manufacturer or other safe

system stakeholders to the well-being of a community.

The United Nations Sustainable Development Goal target to halve road deaths and injuries by 2020 has set the challenge for the world. Road engineers, policy makers and treasury officials must take stock of their role in achieving that target and trigger the scale and discipline of response needed. Linked with action across the full spectrum of road safety action, maximising travel on 3-star or better roads; safer roads can provide one of the silver bullets to deliver results and save lives.

Linked to the achievement of these targets, the communication of success to the general public should form an important part of any safe system policy framework. Automobile clubs, NGOs, business, community groups and government can all play a role in communicating success, and encouraging the next investment that will save further lives.

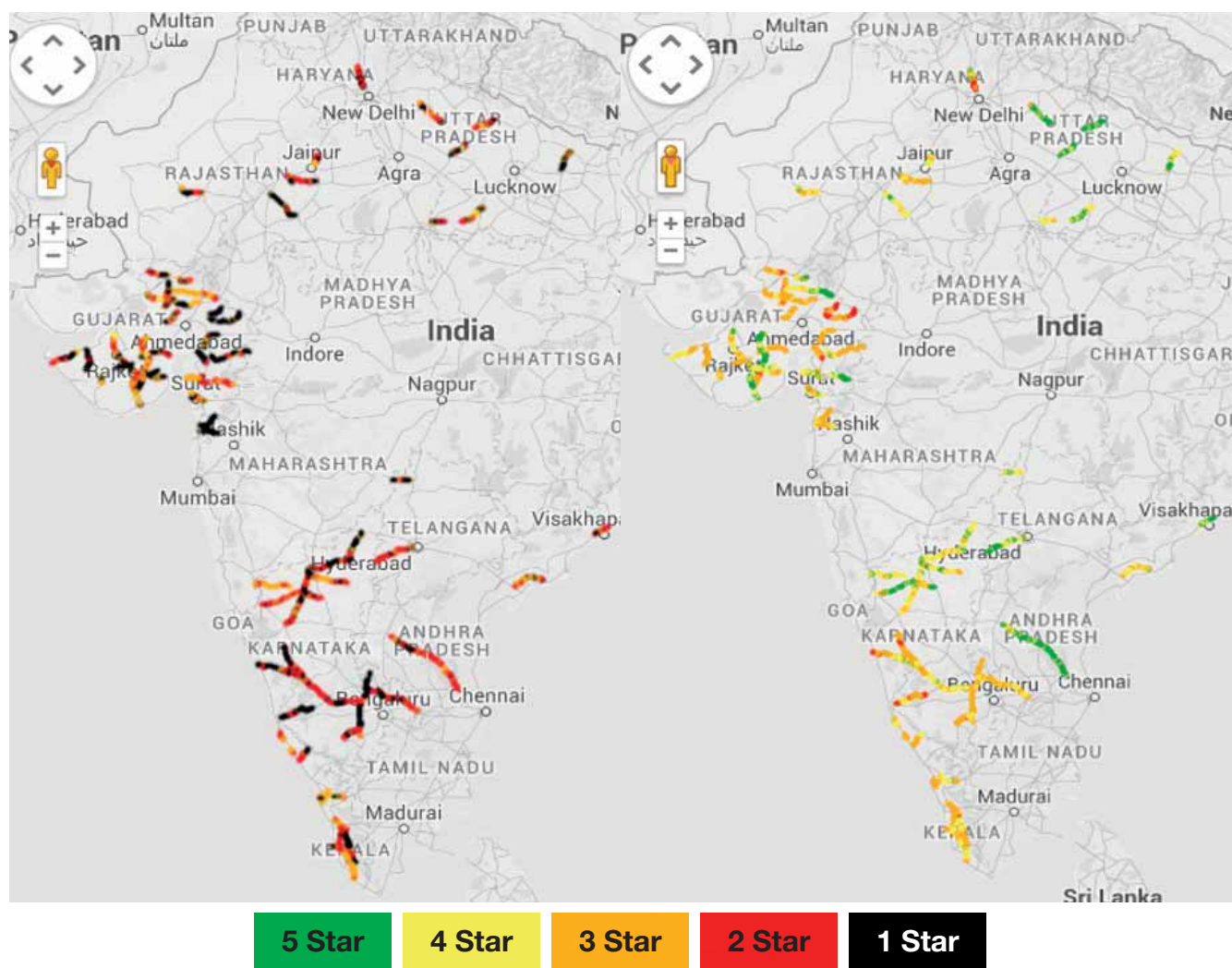


Figure 7: Predicted Before and After Star Ratings in India (World Bank, GRSF)

Saving lives is an achievement worth celebrating. Improving the star rating of a road will facilitate that achievement as politicians and stakeholders ribbon-cut brand new or upgraded 3, 4 and 5-star roads. With the SDG target to halve road deaths and injuries by 2020 we have many improvements to make and much success to celebrate now and into the future.

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Vision Zero as a new way of thinking

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Introduction

Vision Zero

Sweden has a long tradition of systematic road safety work and to consider road traffic injuries as a public problem that must be addressed by the national government. This attitude culminated in the Swedish parliament in October 1997 formally adopting Vision Zero as a new long-term goal and direction in road traffic safety work:

“The goal is that no-one shall be killed or seriously injured as a consequence of accidents in road traffic. The design and function of the road transport system shall be adapted to meet the requirements that follow from Vision Zero” (Swedish Government 1997).

Vision Zero aims to not only influence directly the concrete work on road safety, but also – more indirectly – the institutional preconditions and approaches, which in turn also have an impact on the actions of various players so that they take action to increase the safety of the road transport system. Vision Zero differs in several critical respects from a traditional road safety policy. According to Rogers (2003) classical theory on how innovations are disseminated; an innovation can be defined as an idea, a practice or a product that is experienced as being new by those individuals or other players who adopt it. The fact that those experts who developed the Vision Zero concept experienced it as being something new is perhaps not really so strange, but the thing that makes Vision Zero unique is that Parliament also considered it to be something new. In this way, Vision Zero can be regarded as public policy innovation.

Vision Zero differs from a traditional road safety policy in a number of ways (Belin 2011). A more traditional approach to people killed and seriously injured as a consequence of road traffic accidents has been the utilitarian philosophical approach (Bowen 2012, Belin 2012). Utilitarianism, as it has come to be applied within the road traffic sector, means that safety has to be weighed against other types of benefits. In theory, and to a large extent in practice, this approach means that those killed and seriously injured are a price that society has to pay for the mobility of the road transport system, and that there are an acceptable non-zero number of deaths and serious injuries. Safety shall be gradually improved, but only to the extent that is socioeconomically advantageous. In addition, the traditional road safety work

is based to a large extent on the fact that people are willing to take risks and that it is part of human nature.

The long-term objective of Vision Zero is to create a road transport system in which nobody is killed or seriously injured as the result of a traffic accident. Thus, Vision Zero aims in the long term to create a safe road transport system.

The justification for this absolute and uncompromising attitude is what philosophers would attribute to deontological ethics (Bowen 2012, Belin 2012), i.e. nobody should need to be killed or seriously injured when moving via the transport system from Point A to Point B. Road transportation can be regarded as a type of production. Just as little as society can accept people killing or seriously injuring themselves as a consequence of producing goods and services within an industry can Vision Zero accept it when transportation is produced. According to Vision Zero, mobility is therefore subordinate to safety, at least in the long term. If it is impossible to otherwise create a safe system, it should inexorably have consequences for mobility. Furthermore, Vision Zero is based on the fact that people do not want to die or be seriously injured as the result of a road traffic accident, and therefore each person has his or her own Vision Zero. Vision Zero and a traditional safety policy thus differ from each other when it comes to the long-term objective of the safety work.

Knowledge based on investigations of actual traffic accidents that answer questions about why accidents happen points sharply in the direction of the fact that it is the individual transport user who is the missing link in the road transport system. The traditional road safety activities are to a significant extent based on behavioural science research which draws the conclusion that 90% of all road traffic accidents can be explained by the human factor. In the traditional safety work, the principal challenge is to prevent conscious and subconscious faulty human action (Swedish government 1940). Vision Zero accepts instead, as a basic starting point, that human-beings make conscious and subconscious mistakes, which is why accidents occur, and that the safety work must in the first instance be directed at those factors which can prevent accidents leading to death and serious injury. Accidents in themselves can be accepted, but not their serious consequences.

According to Vision Zero, the principal cause as to why people die and are seriously injured is that the energy to which people are exposed in a traffic accident is

excessive in relation to the energy that the human frame can withstand. Vision Zero is based among other things on the research that the famous American road safety expert William Haddon conducted in the 1960s (Haddon 1968, 1970, 1972, 1973, 1980). Knowledge on energy and tolerance has to a great extent served as a basis for the development we have seen of the passive safety characteristics of vehicles and for the development of different protection systems such as child safety seats, helmets, seat belts, etc. One important consequence of Vision Zero as general policy for safety work is that the view of knowledge that has served as a basis for the development of a sub-component in the road transport system, namely the vehicle, has also become a general principle for the entire road transport system.

In the traditional safety work, ultimate responsibility for safety rests with the individual. According to a traditional view, it is the individual road user who ultimately controls and manages the risks that may occur when travelling on the road transport system. The regulations surrounding the road transport system are clear and unambiguous on this point. If a road traffic accident occurs, it is possible in most cases to hold a certain road user liable for the deficient observance of regulations. Even if, for example, a road authority has made a mistake in the design of a road, it is the responsibility of the road-user, through the general requirements for caution that are built into the traffic legislation, to at the same time provide compensation through his/her behaviour for such shortfalls. According to Vision Zero, it is not the individual road-user who has the ultimate responsibility but rather the so-called system designers. The responsibility for safety is thus split between the motorists and the system designers (i.e. infrastructure builders and administrators, the vehicle industry, the haulage sector, taxi companies and all the organisations that use the road transport system professionally), on the basis of the principles that:

- the system designers have ultimate responsibility for the design, upkeep and use of the road transport system, and are thus responsible for the safety level of the entire system;
- as before, the road-users are still responsible for showing consideration, judgment and responsibility in traffic and for following the traffic regulations;
- if the road-users do not take their share of the responsibility, for example due to a lack of knowledge or competence, or if personal injuries occur or risk occurring for other reasons, the system designers must take further measures to prevent people being killed or seriously injured.

In Vision Zero, the responsibility for safety is a chain of responsibility that both begins and ends with the system designers (Belin 2016).

Traditional safety work is based to a large extent on the notion that individuals and society largely speaking do not ask for safety. There are other values that are given a higher priority, such as accessibility and personal freedom.

Traditional traffic safety strategies are thus based to a large extent on the “unwilling road-user” and society who must be forced into giving consideration to safety (Johnston et al 2014). Vision Zero is instead based on individuals and society demanding safety. The basic starting point of this policy is that everyone has their own “personal vision zero”. The fact that people sometimes act as though they do not require safety has, according to Vision Zero, rather more to do with inability, ignorance and a lack of social support than a lack of will.

The four factors described above (long-term objective, view of reasons for road traffic safety problems, notion of responsibility and people’s requirement for safety) are of great importance for how the safety work can be most suitably conducted. A fifth difference between the traditional safety activities and Vision Zero concerns which safety activity should be given priority first. In the traditional activities it is primarily the safety work directed at adjusting the behaviour of road-users. After this, training and information directed against the users of the system play an important role in the aim of spreading knowledge of the existing traffic regulations.

In order to ensure the observance of regulations by road-users, monitoring and sanctions play an important role. A form of safety work based on Vision Zero shifts the focus from the individual road-user to safe roads, vehicles and traffic environment as well as to a good safety culture (a safe road transport system). Even the kind of problems that we have traditionally experienced as being the behavioural problems of individuals, for example drunken driving, is defined in a Vision Zero perspective as a system problem whose solution lies in strong standards in society and technology in vehicles that prevent drunken driving.

Vision Zero as a policy is sometimes misinterpreted as being a policy that concerns exclusively technical solutions. Vision Zero presupposes behavioural changes for the purpose of creating a safe system, but the most important group to influence is the system designers. Regulations, information, financial incentives, education and training, monitoring, and supervision are all important control measures for bringing about changes in behaviour among system designers. One significant difference in relation to a traditional approach is that considerably greater efforts must be directed at the system designers. Important players in the work on Vision Zero are therefore legislators, road operators, the vehicle industry, professional users of the road transport system as well as citizens and consumers as requirement specifies.

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Addressing key global agendas of road safety and climate change: synergies and conflicts

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Introduction

The latest report by the Intergovernmental Panel on Climate Change identifies, with 95% certainty, that human activities are the dominant cause of observed global warming since the mid-20th century (IPCC, 2014a). The international political response to climate change began at the Rio Earth Summit in 1992, where the UN Framework Convention on Climate Change (UNFCCC) was adopted. Now the UNFCCC has membership of 195 parties, and the annual Conference of Parties (COP) aims to review the Convention's implementation. At the 21st COP in December 2015, Parties to the UNFCCC made a universal agreement (the Paris Agreement), which requires all Parties to put forward their best efforts through "nationally determined contributions" (NDCs) and to report regularly on their emissions and on their implementation efforts, while also assisting developing countries to address climate change. Non-Party stakeholders, including civil society, the private sector, financial institutions, cities and other sub-national authorities were also requested to scale up their efforts. These movements draw stronger attention and resources for climate change globally.

Similarly, delivery of road safety is being increasingly recognised as an urgent global priority, as marked by key events, including the establishment of the United Nations (UN) Decade of Action for Road Safety and the development of the UN *Global Plan for the Decade of Action for Road Safety 2011 – 2020* (UNRSC, 2011). The year 2015 saw the Global Status Report on Road Safety (WHO, 2015), the inclusion of road safety in the Sustainable Development Goals (SDGs), the adoption of the Brasilia Declaration at the 2nd Global High-Level Conference on Road Safety, and the appointment of Mr. Jean Todt as the UN Special Envoy for Road Safety. In 2016, the UN general assembly voted to create a UN fund for road safety. Road safety practitioners worldwide have the task of achieving the particularly ambitious SDG of halving the number of global deaths and injuries from road traffic crashes by 2020. These events and global targets call for scaled up global action and resources for road safety. While high income jurisdictions must continue to drive down the number of deaths and injuries on their roads ultimately to zero, greatly increased investment dedicated to road safety in low and middle income countries, who account for 90% of the global road deaths (WHO, 2015), is critical to drive the number of deaths and injuries down globally.

These two significant global priorities will inevitably compete for finite resources. One way to face this enormous global challenge may be to identify ways to effectively align and integrate road safety and climate change activities. This article considers the alignments and conflicts of actions for road safety and climate change to help identify synergies to achieve both crucial goals more efficiently; and with greater global and national political support, donor support, and private sector support for each agenda.

The common issues for road safety and climate change

Common issues arise between road safety and climate change via a shared source: road based transportation. Approximately 1.25 to 1.396 million people die each year on our roads globally (Haagsma et al., 2015, WHO 2015) and 90% of these road deaths are in low and middle income countries (WHO 2015). Despite the efforts of many in road safety, the first half of the UN Decade of Action has not seen a reduction in road deaths, though the previously existing increase has been stemmed. The transportation sector accounts for 14% of global greenhouse gas emissions, primarily resulting from fossil fuels burned for transportation (IPCC, 2014b). In many countries, the majority of transport emissions are from cars and trucks (Barth 2000, Reddy 2000). Passenger cars are expected to increase from 850 million in 2013 to 2 billion by 2050 with nearly 90% of this growth in non-OECD countries which will have 90% of the additional 2.7 billion urban dwellers (IEA, 2015). Developing countries are expected to account for more than half of the total worldwide travel miles in 2050 (Poudenx 2008). The expected increasingly important role of motorised vehicles in developing countries is alarming for both road safety and climate change in business-as-usual scenarios.

The rapid growth in travel demand combined with limited and lagging transport infrastructure development in developing countries result in rapidly increasing levels of congestion, air pollution, noise pollution, and road traffic injuries and deaths (Reddy 2000). Facilities for pedestrians and cyclists are virtually non-existent in many developing countries, forcing them to share the same roads with motorised vehicles at rapid speeds. The forms of transport which are beneficial for road safety and climate change (public transport, walking, cycling) are exactly the forms of transport the wealthier residents in developing countries do not tend to use, which result in lack of investment to develop and improve those forms of transport for safety and climate change (Reddy 2000). Low-density, sprawled decentralisation such as in North America, Australia, and Europe also generates barriers for public transport to serve efficiently and effectively, leading to growth in car and motorcycle ownership and use (Pucher et al 2008), further leading to congestion, inefficient public bus operations, and harmful effects for road safety and climate change.

Synergies between road safety and climate change

Given the similar issues faced by road safety and climate change, there are opportunities for road safety and climate change practitioners to work in synergy. The synergistic solutions can be considered in accordance with the pillars of Safe System and other transport policy factors.

Safer speeds

The emissions-speed curve has a distinctive parabolic shape, with high emission rates on both ends of speed and low emission rates at moderate speeds. While each vehicle reaches its optimal fuel economy at slightly different range of speeds, gas mileage usually decreases rapidly at speeds above 50 mph/80 km/h (Thomas et al, 2013). When subjected to economic analysis, the economically ideal speed for vehicles (considering crash costs, etc. not just time) on non-urban roads is well below the typical posted speed limit (Cameron, 2012; Hosseinlou, Kheyraadi, & Zolfaghari, 2015). Speed management strategies that bring down excessive speeds to more moderate speeds benefit both road safety and climate change.

If moderate congestion and/or speed limits and speed calming measures such as speed humps, roundabouts or raised platform pedestrian crossings, bring average speeds down from a free-flow speed over 70 mph/110 km/h to a slower speed of 45-55 mph/70-90 km/h, this moderate congestion can reduce CO₂ emissions. In addition, analysis of thousands of real world locations shows that the number of vehicle passing through a given point decreases for speeds of 70 km/h and above compared with 50 km/h (OECD 2006). Maximum traffic flow and more desirable emission rates are achieved at 50 km/h compared to 70 km/h and above.

While the ideal operating speed of vehicles in continuous operation may be higher than urban speeds, studies show speeding, rapid acceleration and braking, waste gas and lower gas mileage by 33% at highway speeds and by 5% around town (Energy and Environmental Analysis, 2001). The ideal speed for these factors will vary with the extent of required acceleration and deceleration, meaning that a uniformly applicable ideal speed cannot be identified. However, vehicle technology that reduces the number and intensity of accelerations and decelerations such as cruise control and intelligent speed adaptation can help maintain a constant speed and save gas, benefiting both road safety and climate change.

Safer vehicles

Management of vehicle safety including adoption of minimum safety standards and safety technologies is an increasingly important global focus in road safety as reflected in the recent UN General Assembly resolution in April 2016 and the important work of Global NCAP. (For more information about Global NCAP see <http://www.globalncap.org>).

globalncap.org/). The primary synergistic opportunity in this arena arises from shared use of regulation, promotion, policy initiatives and enforcement. For example, policies which increase fleet turnover to newer safer greener vehicles provide co-benefits, or in many LMICs policies which reduce the age of imported second hand vehicles can be of assistance to safety and climate. Penetration of 'safe' and 'green' vehicles in the global market is amongst the most sustainable intervention for both road safety and climate change, as once a vehicle is designed and manufactured to a standard and has the appropriate technologies, with reasonable maintenance the benefits should be gained throughout the lifespan of the vehicle, which is approximately 20 years (Ward & Truong 2016). New 'green' vehicles take time to be affordable and to represent a significant share of the total fleet, especially in developing countries where a well-established technology is estimated to take 10 additional years to penetrate in their market (Assmann and Sieber, 2005) and a total of 40-45 years to reach a significant share of the market (Lefevre 2009). In addition, it takes on average at least 15 years for a vehicle fleet to be completely replaced (Ward & Truong 2016). Therefore, without delay, concurrent and prompt actions to saturate the vehicle market with 'safe' and 'green' vehicles are crucial.

In addition to regulation, increasing consumer knowledge

and demand for 'safe' and 'green' vehicles is necessary to achieve fast market saturation. For example, NCAPs assist car buyers make safer purchasing decisions by providing them with independent safety advice which in turn encourages manufacturers to produce safer vehicles. In the same effort, promotion of green vehicles which includes encouraging manufacturers to produce safer vehicles that are more carbon efficient so that safety and carbon efficiency go hand in hand, not achieved in separate vehicles, would be valuable. Alignment of star ratings, technologies, and vehicle design (e.g. ensuring crash protection as well as reduction of aerodynamic resistance of vehicles) for road safety and energy efficiency would make easier consumer choices for 'safe' and 'green' vehicles. Such effort is an especially important consideration in low and middle income countries which are experiencing rapidly increasing motorisation and where availability and uptake of safe and green vehicles are relatively low.

Finally, vehicle equipment is also relevant to both safety and climate change. Hauling cargo on the car roof increases aerodynamic resistance and lowers fuel economy. For example, removal of external cargo containers when not in use; or a large, blunt roof-top cargo box, can reduce fuel economy (Thomas et al, 2014). Similarly, removal of unnecessary items in the vehicle, especially heavy ones, can save fuel costs (Ricardo Inc, 2008). Such weight reductions



Figure 1: The contrast of congestion and risk created by curbside bus operations versus a well-designed BRT system

can also reduce injury severity in the event of a crash. This is especially true for pedestrian crashes because in crashes pedestrians may be forced over the roof of the car, and in such cases the addition of obstacles on the roof add to impact hazard.

Safer roads and roadsides

Three major areas of synergy are apparent. First, speed calming measures which reduce speeds to those which are safer and more fuel efficient in urban contexts will provide co-benefits. Many such measures exist (Makwasha & Turner, 2013; WHO, 2013). Second, the provision of safe system facilities for active transport, such as separated bicycle lanes, increases safety and encourages more climate friendly transport. Third, the appropriate development of bus rapid transit systems (BRTs) can reduce congestion, reduce private vehicle usage, and in net improve environmental factors by using less fuel per person transported. These may also improve safety by allowing for more effective pedestrian access than curbside bus operations (see Figure 1 for an example).

Crash reduction measures

Reducing crashes, especially serious crashes which may take several hours to clear, reduces the congestion caused by such incidents, thus reducing fuel usage and climate and environmental harm. Traffic incidents, including crashes, are estimated to be the cause of 25% of all congestion (US Department of Transportation FHWA 2015).

Reducing private on-road motorised vehicle usage

One of the main determinants of road safety risk is exposure: motorised vehicle use (and more on-road walking or cycling) add to risk. Similarly, motorised vehicle use adds to fuel usage, and climate change, pollution, and environmental degradation (though electric vehicles may

shift the point of fuel usage and add less to pollution). A number of policy levers are available to reduce motorised vehicle usage, including:

1. Provision of off-road public transport alternatives such as ferries and metro systems;
2. Disincentives for private vehicle use. Examples include congestion charge (such as is employed in London), car free days, reduced provision of parking in city centres, and subsidised public transport;
3. Land use planning and urban design to reduce the need for private vehicle usage. The urban sprawl of a city profoundly influences the extent of active and public transport. The contrast of two similar populations in size but with very different land area makes the point (see Table 1, which shows that the city with the low density sprawl has much more driving, many more deaths, and much less active transport: Adriazola-Steil, 2015). Urban planning aligned to both road safety and climate change will be critical to achieve effective and efficient public transport systems that people will choose to use. This is usable information for urban re-engineering. For example, under Mayor Michael Bloomberg 124 neighbourhoods (40% of the city of New York, or 12,500 blocks) were rezoned, so that 90% of all new development is within a 10-minute walk of a subway station (Burden, 2014).

Conflicts between road safety and climate change

While road safety and climate change have many synergistic solutions, it is also important to consider possible conflicts so that they can be better managed.

Table 1. Comparison of Atlanta (USA) and Barcelona (Spain)

City	Atlanta	Barcelona
Population	2.5 Million	2.8 million
Land Area	4,280 sq.km	162 sq.km
Traffic fatality rate (deaths per 100,000 inhabitants)	9.7	1.9
Mode share: cars	77%	20%
Mode share: Public transport	3%	33%
Mode share: Bicycle	0%	12%
Mode share: Walking	1%	35%

Safer speeds

While reduced speeds will provide benefits for road safety and climate change in many circumstances, at some points the curves relating speed to fuel usage and to safety may diverge. For example, in a freeway congestion where the average vehicle speed is reduced to below 45 mph/70 km/h, emissions increase but safety is not harmed. Smoothing the stop-and-go pattern of traffic so that cars move at a relatively constant speed will reduce the emissions, but only under particular methods for achieving this will benefit safety (for example, by grade separating opposing traffic and pedestrians).

Safer vehicles

Smaller and lighter vehicles are more carbon efficient. However, reducing the weight of materials used to build vehicles and vehicle size may compromise safety by reducing the survival space afforded to vehicle occupants in crashes. This issue crystallises in the contrast of motorcycles and cars. A move from cars to motorcycles will reduce harmful effects on climate change but significantly worsen safety (due to the much higher death rate of motorcyclists per vehicle and the difficulty of addressing the safety of motorcycles). It is important that vehicle manufacturers are forced or incentivised to consider concurrently impacts on road safety and climate change, so that vehicles optimal for both road safety and climate change are produced.

Safer roads and roadsides

Managed forests and other lands can act as a sink, absorbing carbon dioxide from the atmosphere (Natural Resources Canada, 2007). Keeping and planting trees are going to be increasingly important to manage climate change. However, trees on roadsides are deadly in the event of a crash, and therefore the environment and road safety sectors will need to increasingly work in collaboration so that trees are managed for both road safety and climate change. This is achievable by managing roadside safety through barriers rather than clear zones.

Reducing private on-road motorised vehicle usage

Promotion of public transport, cycling and walking without the development of safe system facilities for cyclists and pedestrians forces these vulnerable road users to share the road with motorised vehicles travelling at much higher speeds. This can be detrimental to road safety. Therefore, promotion of non-motorised transport for climate change without consideration of consequences for road safety will produce road safety harm rather than co-benefits.

Other co-benefits of synergistic solutions for road safety and climate change

Other health related agenda will also receive co-benefits from addressing road safety and climate change via some of the mechanisms and policy changes considered herein. For example, reduced urban speeds, increased use of public transport, and increased provision for active transport will provide a number of additional benefits. These benefits include:

1. Reduced noise pollution which is a significant negative factor in life quality (Job, 1988), learning (Haines et al., 2001), mental health (Stansfeld et al., 1996), and physical health (Job, 1996; WHO Regional Office for Europe, 2012);
2. Reduced air pollution, which is a significant health factor (WHO, 2013);
3. Reduced obesity related diseases due to more active transport, though this factor is less immediately relevant in low and middle income countries (LMICs), where 90% of the road crash deaths occur (WHO, 2015);
4. Increased equity of access/inclusion, especially in LMICs. For example, more extensive affordable public transport, and lower traffic speeds in urban contexts increase safety and allow more access for the poor, because the poorest people are more likely to be pedestrians whose access is reduced by high speed urban roads which are more difficult to cross, while higher vehicle speeds primarily benefit those who are able to afford a vehicle.

Conclusion

Many activities which will deliver road safety also provide co-benefits for climate change, as well as health benefits due to reduced noise, reduced air pollution, and increases in active transport. The synergies between road safety and climate change far outweigh any points of conflict. Focus on the activities with clear co-benefits allows for more efficient delivery of benefits for multiple agendas. Primary amongst these activities are reducing travel speeds, improving vehicle standards, and reducing use of private motorised vehicles. Many policy, regulatory, and infrastructure levers exist by which these co-benefits may be accessed. Finally, the promotion of these co-benefits may assist in garnering stronger political support for road safety as well as climate change.

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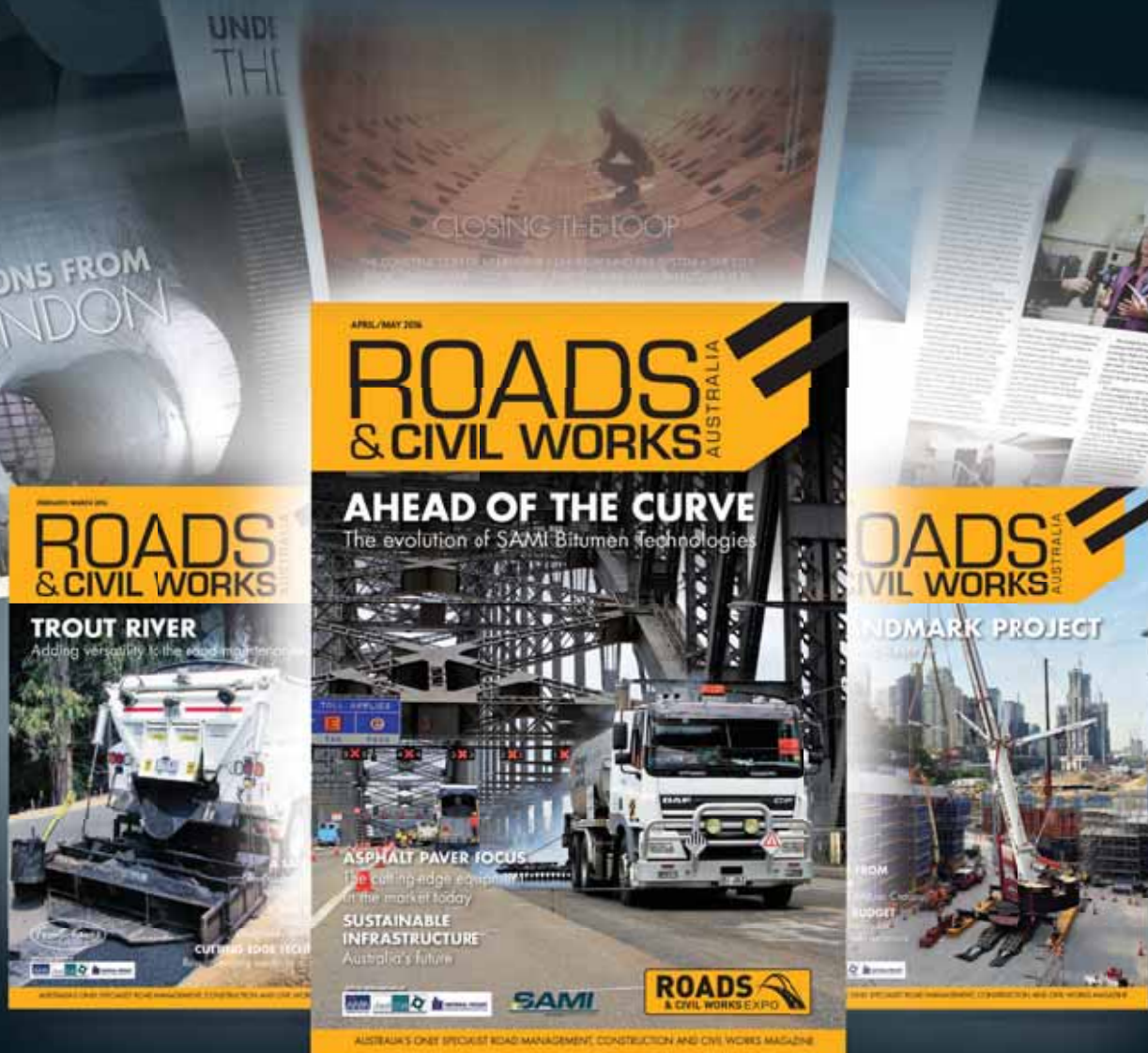
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