Vol 27 No 2, 2016

Journal of the Australasian College of Road Safety

Formerly RoadWise – Australia's First Road Safety Journal

Special Issue: Global road safety – leadership and delivery

Peer-reviewed papers

- Traffic safety: emerging concerns for low and middle income countries
- Malaysian road fatalities prediction for year 2020
- A resource allocation model for traffic enforcement

Contributed articles

- The status of global road safety: the agenda for sustainable development encourages urgent action
- Assembling the case and the coalition to achieve road safety's SDG health target
- Road Safety: A step towards achieving the global goals
- Global enhancement of vehicle safety – the urgency of now
- The role of GRSP in global road safety and priorities for achieving ambitious road fatality reduction targets
- The Multilateral Development Banks´ road safety initiative
- Making impacts through the Global Road Safety Facility
- Management of speed: the low-cost, rapidly implementable effective road safety action to deliver the 2020 road safety targets

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Entries open 1st February 2016 and close 5pm (EST), 24th June 2016

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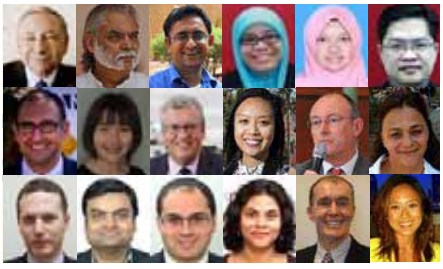

Cover image

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: J Todt, D Mohan, K Bhalla, R Sarani, S Allyana, W ShawVoon, S Billingsly, E Jones, D Ward, J Truong, B Watson, H Gomez Velez, M Shotten, D Bose, R Tabbara, SL Hettiarachchi, RFS Job and C Sakashita. Names of authors for whom a photo was not available: M Peden, T Toroyan, E Krug, K Iavch.

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The College encourages interested persons and organisations to submit articles, photographs or letters for publication. Published letters would normally show the name of the writer and the state or territory of residence. The journal provides the opportunity for researchers to have their work submitted for peer review, in order to improve the quality of their research papers. However, peer review cannot guarantee the validity of research nor assure scientific quality. The publisher reserves the right to reject submissions or, with approval of the author, to edit articles. No payment is offered for articles published.Material in this journal may be cited with acknowledgement of the full reference, including the author, article title and the year and volume of the journal. For permission to reprint articles, please contact the Journal Managing Editor.

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From the President

Dear ACRS members,

Unnecessary road trauma is a major global issue. The extent of the trauma from road crashes has been generally unrecognised in international policies for many years although since the UN First High Level Conference on Road Safety in Moscow in 2009 and the Second Conference in Brasilia last year, as well as a range of other events, the extent of the trauma, the social and economic cost to society, especially in developing countries, is becoming better understood. The need for action plans and real actions based on good, sound evidenced based system solutions are becoming more widely recognised.

Fortunately, the UN and the WHO through their organisations such as GRSP, the Development Banks led by the World Bank, the Bloomberg Foundation, the FIA Foundation for Mobility and Society with their many member motoring associations, IRF, IRAP, GNCAP, many governments, user groups, researchers in many institutions and so many others are taking up the challenge to make a 50% reduction in road trauma by 2020. The recognition that road trauma should not simply be categorised as a necessary, but unfortunate component of personal mobility, but to be included in our community sustainability and health well-being goals, so we can all have safe personal mobility in the many modes is vital.

This Journal contains a wide range of papers and articles from authors in some of these organisations and has been compiled by our guest editors, both well known in the world and local road safety community, Dr RF Soames Job (FACRS) and Chika Sakashita. They will also be guest editors for our next edition and we thank them for drawing so many papers together. We are also delighted that Soames will be joining us as a Keynote Speaker at the 2016 Australasian Road Safety Conference to be held in Canberra in September this year.

These two Journals on the international dimensions of road trauma will make a contribution to help us learn of the extent of the problem and help us in the many phases of our work.

When we work together in coalitions at every level in society, across professional portfolios, in the connections with infrastructure, vehicle investment and technologies, in behavioral and enforcement management, in post trauma care, as well as across geographic boundaries we can build the synergy so urgently needed to reduce the unnecessary trauma from road crashes. The College is proud to encourage and support collaborations such as those highlighted across these two special editions of the ACRS Journal. We continue to strive to provide comprehensive and well-respected platforms such as the Journal, the ACRS Weekly Alert, Australasian Road Safety Conferences, Chapter events and a variety of prestigious Road Safety Awards to share and celebrate all that is being worked towards and achieved. We thank you, our members, for supporting all of our activities, and for being an important part of the complex mechanism that is working to bring about road trauma reductions.

Lauchlan McIntosh AM FACRS
ACRS President

Global Road Safety: two special issues

Guest Editors, May and August 2016

Chika Sakashita, PhD. Senior Project Leader, Road Safety, Global Road Safety Solutions, chika.sakashita.grss@gmail.com

RF Soames Job, PhD. (FACRS) Global Lead, Road Safety & Head, Global Road Safety Facility, World Bank, sjob@worldbank.org (This Guest Editing role was accepted before taking up this World Bank role.)

May 2016 marks the midway point since the launch of the UN Decade of Action 2011-2020 in May 2011 in over 110 countries with the aim of saving 5 million lives by 2020. As of January 2016, we also have the renewed Sustainable Development Goals including key global road safety targets set for 2020 and 2030.

Since the inception of the Australasian College of Road Safety in the early 1980s, it has expanded to include Chapters all around Australia and New Zealand, and has members in many other countries (Canada, China, France, Italy, Mauritius, Switzerland, Thailand, Netherlands, United Kingdom, USA) reflecting its increasingly global focus. The Journal of the Australasian College of Road Safety is the only peer-reviewed scientific and policy journal with “Road Safety” in the title. In these contexts, we as the Guest Editors feel it is crucial that the Journal of the Australasian College of Road Safety (ACRS Journal) draws attention to global road safety to stimulate the delivery of the UN Decade of Action 2011-2020 and key road safety targets within the Global Sustainability Goals. “Global Road Safety: Leadership and Delivery” will therefore be

the key theme of the ACRS Journal over two consecutive special issues in May and August 2016.

Over the two special issues we have a collection of papers from international organisations who play key roles in providing leadership, management, funding, advocacy, evidence-base and delivery of road safety globally. We are most grateful to the many international leaders in the field who have prepared papers for these two issues. Vision Zero and Safe System which set out eliminating death and serious injury as the primary focus are increasingly being acknowledged and adopted in many countries as the foundation to guide our actions to eliminate road related deaths and debilitating injuries. Under Safe System we as a global community recognise that road users inevitably make mistakes and developers and managers of the roads, vehicles, and speed must provide a forgiving road transport system which accommodates inevitable human errors to prevent road transport related fatalities and injuries. In line with Vision Zero and Safe System, the papers across the two special issues will cover the key pillars and functions of safe road infrastructure, safe vehicles, safe speeds, safer road user behaviour, road safety funding, leadership and management.

As emphasised in the papers in this first issue by the UN Special Envoy for Road Safety, Jean Todt, and the World Health Organisation (WHO) 1.25 million people die each year on our roads globally and 90% of these road deaths are in low and middle income countries. The Global Burden of Disease estimate is somewhat higher at 1.396 million deaths (Haagsma et al., 2015). In addition, between 20 and 50 million people suffer injuries with many resulting in disability. Road traffic injuries are also the leading cause of death among young people aged 15-29 years (WHO, 2015). This is an enormous loss to victims, their families (who may be driven into poverty by the loss of the family breadwinner in addition to their grief), and to the community as a whole in terms of incalculable emotional suffering as well as profound economic costs (Bose, 2015; McMahon & Dahdah, undated, and see the IHME-World Bank report: Bhalla et al., 2014).

These are surprising and tragic statistics when road crash deaths and injuries are predictable and therefore preventable. Both the WHO's Global Status Report 2015 and the Global Burden of Disease analyses show that the number of road deaths has remained fairly constant since 2007. While this is an improvement in a sense that global motorisation and population have risen in the same period, a disturbing number of lives are still being lost from a preventable cause every year. The papers across the two special issues echo the enormity of this road transport trauma and the need for urgent actions to address it.

In particular, low and middle income countries are in desperate need of funding support to mitigate the large majority of the world's road deaths which occur in those countries. It is encouraging that funding support from high income countries is occurring. Funding support is occurring globally as exemplified by the UK Department for International Development and the FIA Foundation (see the papers herein from Elizabeth Jones and Saul Billingsley). Closer to home, in 2014/15 Australia invested approximately AUD250 million in transport infrastructure in countries such as Indonesia, Papua New Guinea, the Philippines, Viet Nam, and countries of the Pacific. This includes funding for road safety. In Indonesia, for example, part of this Australian investment has provided technical assistance and grants on road safety, including working with selected Indonesian cities to address the safety of pedestrians, cyclists and motorcyclists (Information kindly provided by Department of Infrastructure and Regional Development, Australia). Greatly increased investment dedicated to road safety in low and middle income countries is even more critical today to drive the number of deaths and injuries down globally.

The papers herein provide compelling presentations of the size and cost of the road safety pandemic; the opportunities presented by the SDGs; the need to integrate road safety more effectively into the broader global development agenda; the need for greater catalytic funding; as well as challenges and directions for action to deliver road safety in low and middle income countries. We hope that the papers from leading international organisations across the two special issues of the ACRS Journal will assist to inspire urgently needed re-invigorated funding, stronger commitments and more powerful actions which we as a global community need to take with urgency to reduce the global road trauma we suffer today.

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Tackling the invisible pandemic on our roads

Message from UN Secretary General's Special Envoy for Road Safety and FIA President, Jean Todt

Look up the definition of the word pandemic in any dictionary and you will find an entry that describes a disease or condition causing mass suffering on a national, international or, at its most terrifying, on a global scale. The prospect of such an event, a condition that would decimate communities, irrevocably affect the lives of millions and create seismic economic repercussions that deeply impact the progress and aspirations of entire nations, is simply horrifying.

How sad, then, that this is a condition we almost unwittingly continue to live with each and every day, in which we are all in some way complicit -- yet which we know how to cure.

I am talking about deaths and injuries from road traffic crashes. Every year on the world's roads almost 1.25 million people die. According to the World Health Organization, road traffic accidents are now the eighth leading cause of death globally, and the leading cause of death among young people aged 15-29 years.

Even more alarmingly, over 186,000 children die globally each year from road crashes -- that's more than 500 children every day, one every three minutes.

And yet, in the vast majority of cases, these tragic deaths, which in our desire for access to mobility we somehow translate into "acceptable losses", will on any given day barely merit a brief news snippet.

This is a situation that, along with many others around the world, I am determined to address.

It's time for global action.

Great strides have already been taken to arrest the spread of this plague. In 2011 the United Nations, in recognition of the crisis we are living through, launched a Decade of Action for Road Safety, the goal of which is to save 5 million lives on the world's roads by 2020. Huge efforts have been made to bring this issue to the top of the global political agenda and the road safety community has had success - but not enough.

The simple fact is that the numbers of road deaths are increasing and as the Decade of Action has reached its midpoint we are in danger of missing the ambitious targets we have set to halt this pandemic.

Recognising this, UN Secretary General Ban Ki-moon recently decided that the mission required renewed focus and in addressing this he bestowed upon me the great honor of becoming his Special Envoy for Road Safety.

For me, this is an enormous responsibility but also a tremendous opportunity. For the past five years, in my role as President of the FIA, I have made road safety a guiding priority of the organisation and in a bid to present road safety as one of the major health and development issues of our time, I have travelled around the world met heads of state, government departments, development organisations, non-governmental organisations, road safety experts, and mobility clubs.

During that time, the one thing brought home to me on countless occasions is that to effectively press for change on a worldwide scale requires us to speak from a global platform.

I believe that coordinating the construction of this global platform is what the role of Special Envoy was created to achieve. This post can act as a catalyst for change, creating a focal point in terms of mobilising the road safety community, world leaders and governments to fight for safer roads, safer vehicles, better driving rules and more effective enforcement.

Gathering political will across the world

The tools to achieve all this are already at hand. Over the past decades, under the auspices of UNECE, the United Nations has developed 58 conventions and agreements in relation to international transport. Many of them govern a huge variety of road safety areas, such as traffic rules, the standardisation of road signs and signals as well as vehicle standards.

These legal instruments are in place: we know how to build safer vehicles; we know how to build safer roads; we know the benefits of advanced and consistent traffic rules and road signs in making people use roads more safely. Yet there remain nations and regions that have not adopted these instruments. If we could get these instituted and correctly policed on a global footing we would see a dramatic improvement in road safety in the most crucial areas of the globe - the low- and middle-income countries where a staggering 91 percent of worldwide road deaths occur.

Engendering the political will to act in those who believe that inaction is more cost effective will be key. It is a task I accept with relish for the simple fact that the effects of road traffic accidents have a huge impact on the economic wellbeing of nations, costing as much as three percent of

GDP of some countries annually.

If we can convince governments to spend a little to deal with the symptoms of this disease, we would save a lot - in financial, but most importantly in human terms.

The inclusion of road safety in the new Sustainable Development Goals agreed by the UN General Assembly last September was a new crucial landmark. In a historic decision, with thanks to the joint work of the road safety community, road safety targets were included in the goals for both Health and Cities.

A very ambitious target was set: road deaths should be halved by 2020, from 1.25 million today to 600,000 in five years' time. This is certainly not a minor challenge, which will only be achieved if we dramatically upscale our efforts.

Creating innovative, effective financing models

There is an urgent need to radically increase funding for road safety and we need to do more to encourage the private sector to make a substantial commitment.

We need to look beyond established, sometimes obsolete and ineffective models and be open and flexible to explore new ways of financing. One idea I have called for, along with the road safety community, is the establishment of a financing mechanism based on the model of UNITAID and the contribution from plane tickets. This would take the form of marginal contribution on sales related to the automotive sector. Such a mechanism could rapidly generate extensive funding, which could then be poured into a global UN Fund for Road Safety to help developing countries face the challenges of road safety.

The FIA High Level Panel for Road Safety

On 11 November last year, the FIA High Level Panel for Road Safety was launched. The initiative brings together leaders from the global business community, international institutions and non-governmental organisations, to create and implement innovative solutions to road safety's most pressing challenges.

Today I am proud of the interest and engagement which the initiative has generated from leaders around the world who have offered their time, energy and goodwill to build new momentum for road safety actions around the world.

The primary objective of the Panel is to increase awareness and generate new funding for road safety actions in low- and middle-income countries. These are key priorities also of my mandate as Special Envoy, even if planning for the new High Level Panel began long before I was appointed as a Special Envoy.

The Panel also aims to make a significant contribution towards increasing engagement with the private sector. Of course, governments are the major actor, as public policies are the main determinants of road safety.

But private companies also have a substantial role, especially, but not only, those more directly linked to the mobility of people: car manufacturers, insurance companies and so on. All of them have an interest and a responsibility in improving the level of safety on the streets and roads of the world. And we want to make sure that this interest and this responsibility leads to tangible outcomes.

High-income countries have made great progress over the past 30 years to dramatically reduce road related fatalities. We now need to extend that progress to rapidly developing low- and middle-income countries.

Conclusion

These are long-term goals and they will be hard won - through advocacy at the highest levels, through lobbying at international, national and local level, through the development of better funding mechanisms and through a constant conviction that change can be brought out if we speak loudly enough and with one voice, pressuring those who would continue to relegate this global scourge to the realm of acceptable and affordable losses to look beyond the news in brief and to recognise the pandemic on their doorstep.

Diary 2016

May 11-12
Designing for Pedestrians and Bicycle Riders
Rydges Sydney Central Hotel 22-44 Albion St,
SURRY HILLS Sydney
http://www.sustainabletransport.com.au/training1.html

May 17-19
Road Safety on Five Continents (RS5C)
Rio de Janeiro, Brazil
http://www.vti.se/en/road-safety-on-five-continents

May 19-20
RA National Roads Summit: All Roads Lead to a Connected Future, SMC Function Centre, 66 Goulburn Street, Sydney
http://www.roads.org.au/event-details?EventId=1720

May 24-26
Asia Pacific Road Safety, Beijing, China
http://www.grsproadsafety.org/news/save-date-asia-pacific-road-safety-24-26-may-2016-beijing-china

May 31- June 2
Autonomous vehicle test and development conference
Stuttgart Germany
www.autonomousvehiclesymposium.com

Head Office News

Chapter reports

Queensland Chapter

April 2016

The quarterly seminar and Chapter meeting held on 2 June 2015 titled "Road Safety in Bali" was presented by Dr Dewa Made Priyantha Wedagama.

Dr Wedagama is a lecturer in the Department of Civil Engineering with the Udayana University, Bali Indonesia and has a particular interest in transport safety. Dr Wedagama has conducted and published research on transport safety particularly focussing on motorcycle and pedestrian safety within Indonesian provinces.

September was dedicated to the ARSC2016 Conference which was held on the Gold Coast.

The Queensland Chapter began 2016 with a quarterly seminar and Chapter meeting on Tuesday, 1 March 2016. The seminar "Challenges for LDMPs in meeting Best Practice" was presented by Dr Tanya Smyth, Research Associate, CARRS-Q.

Tanya Smyth is a Research Associate at the Centre for Accident Research and Road Safety - Queensland. She has expertise in health behaviour research, particularly regarding learner driver mentor programs, and driving impairment related to the use of prescription medicines. She is currently leading an evaluation, funded by the Motor Accident Insurance Commission, of a Queensland-based learner driver mentor program.

The Queensland Chapter will hold its Annual General Meeting on 7 June 2016. Preceding the AGM will be our next seminar. Speaker to be announced soon.

Information prepared by Veronica Baldwin, Mark King and Kerry Armstrong

ACT and Region Chapter

The ACT Chapter has an exciting year ahead of it. It hosts the 2016 Australasian Road Safety Conference in September and will provide assistance to the organising committee during the year and the conference itself. A committee has been established to plan and organise social activities for delegates to the conference and initial decisions and bookings have been organised.

The Chapter hosted a forum and workshop, ***Riding rural roads safely***, on motorcycle safety on 18 February 2016. A report of the event follows this Chapter report.

The Chapter continues to support the safety initiatives of the Yass Valley Council's ***"You Don't Have to be Speeding - to be driving too fast on country roads"*** road safety campaign. A major Easter-School Holidays campaign was launched on 1 March on the outskirts of Canberra. Melissa Weller, the Council's RSO, is an active member of the Chapter.

As for the remainder of the year, the Chapter is planning:

- a truck safety activity in conjunction with the ATA's Safe Truck program and the Transport Industry Training Centre in Queanbeyan; and
- the 2016 Road Safety Forum with the ACT Justice and Community Safety Directorate around November.

The following report of the Riding Rural Road Safely Forum was prepared by Joanne Wilson Ridley, Road Safety Officer with the Queanbeyan City Council

June 9-10
7th International ESAR Conference: Expert Symposium on Accident Research, Hannover, Germany
http://www.esar-hannover.de/?Index

August 2-5
ICTTP2016: The Sixth International Conference on Traffic and Transport Psychology, Brisbane Convention and Exhibition Centre, Queensland, Australia
http://icttp2016.com

September 6-8
Australasian Road Safety Conference (ARSC2016)
Canberra, Australian Capital Territory
http://australasianroadsafetyconference.com.au/

October 10-14
23rd ITS World Congress
Melbourne, Victoria
http://www.itsworldcongress2016.com/

October 17-20
Habitat III
Quito Ecuador
https://www.habitat3.org

November
UN Conference on Sustainable Transport

Riding Rural Roads Safely: a forum for stakeholders in motorcycle safety in ACT/NSW Region

The ACT and Region Chapter hosted their first event for the year on 18 February 2016. 'Riding Rural Roads Safely' gathered stakeholders to discuss motorcycle safety with the aim of developing co-ordinated initiatives for encouraging riders to minimise their risks.

The need for this regional initiative was first identified at last year's ACT-ACRS Road Safety Forum. Station Sergeant Susan Ball from ACT Police acknowledged this when addressing the forum, noting that the motorcycle safety issues being experienced in ACT and surrounding region couldn't be solved by police alone. "A coordinated effort was needed" said Sgt Ball, and she extended her thanks and congratulations to organisers for drawing together a broad range of stakeholders to tackle the issue.

Geoffrey Davidson, the Manager, Road Safety for Justice and Community Safety ACT, noted the timely relevance of the forum with the recent launch of ACT Government's Road Safety Action Plan 2016-2020, which will see the introduction of new driver competencies relating to vulnerable road users, including motorcyclists and the establishment of a vulnerable road user safety improvement program.

The first half of the program saw four invited speakers address the forum outlining current motorcycle initiatives in the region from RMS Southern Region, Tumut Shire Council and Stay Upright motorcycle training. Associate Professor Kristen Pammer also presented to the forum current motorcycle research from the ANU's Applied Cognition and Transport Safety Lab. Dr Pammer framed the challenges for motorcycle safety discussing hazard detection results for road users that indicated gains could be made by changing driver expectation and awareness of motorcyclists.

The second half of the program provided the opportunity for delegates to work in smaller groups brainstorming the vision for motorcyclists of 'Making it home safe'. When results from these sessions were shared with the whole forum it was evident the workshop approach had been fruitful and groups had benefitted from the contributions of the diverse range of stakeholders including Motorcycle Associations, Motorcycle Rider Groups, ACT Police, ACT Ambulance, ACT Parks and Conservation Service, Local Government Road Safety Officers, M.A.R.I and Motorcycle Rider Training. Benefit was particularly noted from visiting representatives from Hunter region Local Governments who shared details of their national award winning motorcycle safety programs.

In moving forward Geoffrey Davidson guided the forum's discussion to identify agreed action in the key areas of motorcycle peer-to-peer influence, rider training and protective clothing initiatives.

In closing the event, the NRMA-ACT Road Safety Trust were acknowledged for their grant funding and delegates committed to ongoing communication to facilitate the development of the identified key areas into coordinated initiatives and regional projects. The ACT Chapter and Region wishes to thank all the speakers and delegates that contributed to the forum's success in sharing knowledge and workshopping the challenges facing motorcycle safety in the region.

Peer-reviewed papers

Traffic safety: emerging concerns for low and middle income countries

by Dinesh Mohan[1] and Kavi Bhalla[2]

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Abstract

This paper examines the data available from published reports to understand the shortcomings in our present understanding of the following road safety issues: the relationship between national income and traffic safety; relative risk of different categories of road users in different societies; and urban form and traffic safety. Promoting, rather than effectively enforcing a few well-known safety countermeasures like helmet and seat belt use; weak efforts at controlling speeds and drinking and driving; and crashworthiness standards for cars may not be enough to substantially lower road traffic fatality rates internationally. Patterns of motorised two-wheeler and paratransit vehicle crash rates seem to be different in low and middle-income countries. Much more detailed research needs to be done in low and middle-income countries by establishing research centres to address local issues in these countries.

Keywords

Low and middle-income countries; Motorcycles; Small vehicle crashworthiness; Fatality rates

Introduction

The World Health Organization (WHO) released its World Report On Road Traffic Injury Prevention in 2004 (Peden et al 2004). This report focussed on road traffic injuries (RTI) and fatalities as a worldwide health problem and included a summary of the known risk factors associated with road traffic crashes and possible countermeasures that should be put in place to control the problem. It also pointed out that "Without new or improved interventions, road traffic injuries will be the third leading cause of death by the year 2020". The publication of this report spurred some national and international agencies and civil society groups to give a little more attention to the problem of road safety and a number of resolutions have been passed by the United Nations General Assembly, World Health Assembly and the Executive Board of the WHO. The WHO has released three Global Status Reports On Road Safety in 2009, 2013 and 2015 (WHO 2009, 2013 and 2015). These reports offer a broad assessment of the status of road safety in over 175 countries. The data were obtained by the WHO from national governments using standardised survey forms.

The latest WHO Global Status Report shows that low-income and middle-income countries on an average have higher road traffic fatality rates (24.1 and 18.4 per 100,000 populations, respectively) than high-income countries (9.2 per 100,000 population). These estimates are based on regression models that rely on national death registration data and seek to correct for substantial underreporting in official government statistics that are usually based on traffic police reports. WHO's modelled estimates exceeded official statistics by more than 20 per cent in 60 per cent of the countries.

The Status Report estimates that 49 per cent of those who die in road traffic crashes are pedestrians, bicyclists and users of motorised two-wheelers (MTW). However, this is likely an underestimate because WHO's estimates rely on official government statistics to estimate the proportion of different types of road users killed. For example, in the latest report the data for India includes the proportion for pedestrian and bicyclist deaths as 9 and 4 per cent respectively. However, a recent research report from India suggests that pedestrian and bicyclist deaths may be in the range 39-45 per cent (Mohan et al 2015). Similarly, the Status Report and official statistics from China report that 26% of deaths are pedestrians. However, China's national burden of disease estimate, which are based on national health data, suggest that pedestrians comprise 53% of traffic fatalities (Zhou et al 2013). Though some of the data in these Status Reports may not be accurate, they do provide a rich source of information that was not earlier available.

The 2015 Report suggests that "Changing road user behaviour is a critical component of the holistic 'Safe Systems' approach advocated in this report. Adopting and enforcing good laws is effective in changing road user behaviour on key risk factors for road traffic injuries

- speed, drink-driving, and the failure to use helmets, seat-belts and child restraints properly or at all." These recommendations are similar to those included in earlier reports and have been adopted by most international agencies promoting road safety in low- and middle-income countries (for example, Bloomberg Initiative for Global Road Safety and Global Road Safety Partnership). Focus on these five risk factors is unexceptionable, as they would work in every country if controlled successfully. However, all these interventions require implementation and enforcement of traffic laws that is not as straightforward or easy. For enforcement to create a meaningful deterrent threat, enforcement activity needs to be increased substantially and maintained over a long period so that road users perceive a high risk of being ticketed (Zaal 1994). Severe penalties and quick punishment are not effective unless drivers believe that there is a high risk of apprehension. However, large increases in traditional (manual) police enforcement will often not be politically acceptable, especially in settings where traffic stops are used by police as a tool for crime prevention and broader social control (Epp et al 2014). For some domains, such as speed control, there are emerging automated technologies that may allow large increases in enforcement without concomitant increase in direct contact with police personnel. However, large-scale deployment of these technologies in low- and middle- income countries remains largely untested. This may be why most local agencies and governments fall back on 'education', driver training and behaviour change campaigns that are usually not very successful (Williams 2013; Williams AF 2007; Williams AF 2007a; Robertson 2007; Haddon WJ 1968).

Another important stream in global intervention strategies is in the promotion of universal motor vehicle safety standards. There are two approaches to improving car design: (1) legislation that prescribes requirements with which vehicle manufacturers need to comply, and (2) information programs by organisations like Global New Car Assessment Programme (Global NCAP) that provide safety ratings for cars and allow car buyers to pick safer cars. Again, this activity is desirable and must be promoted to make cars safer for their occupants.

However, these approaches need to be tailored to the particular context of every country. Creating a market for safety through star ratings of cars can influence drivers to buy vehicles that protect vehicle occupants but are unlikely to influence vehicle design improvements for the safety of road users outside the car. However, in many countries car occupants comprise less than 10-20 per cent of road traffic fatalities (WHO 2015; Mohan 2015). Thus, it is important to legislate vehicle design standards that improve the safety of pedestrian, bicyclists and motorcyclists in collisions. Furthermore, these standards need to include buses and trucks, which comprise a large proportion of vehicles that impact vulnerable road users (Mohan 2015){Epp, 2014 #2556}. Exclusive focus on cars also ignores some important issues of relevance to low and middle-income countries (LMIC), such as safety of paratransit vehicles (three-wheeled taxis, tuk-tuks, jeepneys, etc.).

The WHO reports do mention the need for focussing on safer street design in urban areas, but urban planners and policy makers in most LMIC are not giving enough attention to this issue. This is possibly because the role of urban planning in promoting road safety is still not well understood. It is only recently that some of these issues have been highlighted by Cho et al 2009; Dumbaugh 2013; Ewing and Dumbaugh 2009; Miranda-Moreno 2011 and Mohan and Bangdiwala 2013. They suggest that the existence of big urban blocks, high proportion of wide arterial streets and even proliferation of big box stores may increase road traffic crash risk. Urbanisation is going to be an important feature of development in most LMIC, therefore, it is essential that we develop a more nuanced understanding of these issues so that road safety can be promoted in a more integrated manner.

In this paper the data available from published reports is examined to understand the shortcomings in our present understanding of the following road safety issues:

- Relationship between national income and traffic safety
- Relative risk of different categories of road users in different societies
- Urban form and traffic safety

National income and traffic safety

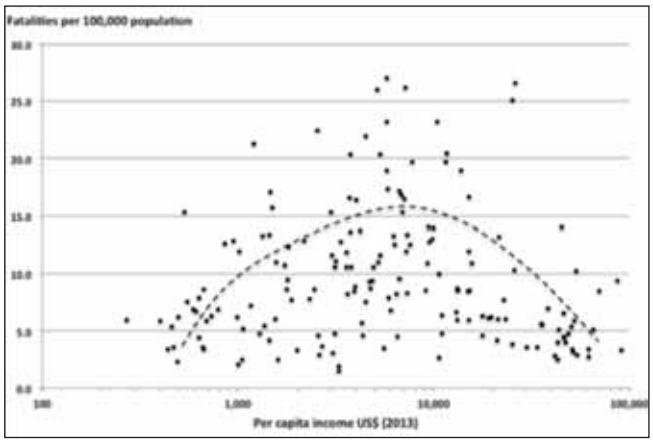

Figure 1. Fatalities per 100,000 population (official data from countries) vs. national per capita income for 171 countries. Source (WHO 2015)

Figure 1 shows a plot of fatalities per 100,000 population versus per-capita income of various countries based on the official reports from countries as reported by WHO (WHO 2015). Fatalities per 100,000 population is used for most comparisons in this paper because the index is a good indicator of the health burden on the population. Fatalities per population can also be used as proxy for risk of death per trip, as international experience suggests that the average number of trips per person remains relatively stable over time, incomes and place according to Knoflacher (2007). Knoflacher further states that average trip rates

in cities around the world vary from 2.8 to 3.8. That total trip rates do not vary much and generally remain between three and four trips per person per day has been supported by many studies around the world (Giuliano and Narayan 2003; Hupkes 1982; Santos et al 2011; and Zegras 2010.

Data presented in Figure 1 suggest that road traffic fatalities per unit population increase initially as societies become richer but begin to decline after the society reaches a certain developmental threshold. However, it must be noted that 60 per cent of these countries, especially low and middle-income ones, may have underestimated the total number of deaths as mentioned earlier. Such multi-country data and historical data from some high-income countries from Western Europe and North America have been used by many researchers to model the relationship between per capita income and road traffic injury (RTI) fatality rates (e.g. Kopits and Cropper 2005; Koornstra 2007. The model developed by Kopits and Cropper predicts that the income level at which traffic fatality risk first declines is US$8,600 (1985 international prices). According to this model they predicted that the "road death rate in India, for example, will not begin to decline until 2042". Using a more complex model Koornstra predicted that road traffic fatalities may start declining in countries like India around 2030 if corrective actions are taken by policy makers in a 'learning scenario'. Both these predictions may be somewhat pessimistic if we take note of the more recent data and analyses made available to us.

While Figure 1 shows official statistics, Figure 2 shows the WHO estimates of road traffic fatalities for the same countries as in Figure 1, plotted against national per capita income (WHO 2015). These data have a very different distribution from that in Figure 1. Here we see a general tendency for a decrease in fatality rates with increasing incomes across countries. The rise and fall of traffic deaths in Figure 1 appears to be largely due to underreporting of traffic deaths in LMIC. Therefore, it is possible that our earlier understanding that fatality rates will continue to increase until societies reach income levels between US$10,000-20,000 (2013 international prices) before decreasing may not be correct. A study by Castillo-Manzano et al (Castillo-Manzano et al 2014) examining the trends in road traffic fatality rates in a sample of European states over the 1970–2010 period shows that "the convergence of EU countries as a whole on road safety being a clear empirical fact, as the countries with traditionally higher fatality rates at the beginning of each period have experienced a more negative average rate of change". They conclude that convergence on road safety is possible even without economic convergence, but the exact reasons for the same are not clear.

It is possible that there is not necessarily a relationship between income and road safety performance when other factors are controlled. Both Figures 1 and 2 show a very large variation in road safety performance of countries at the same income level. This is true for countries at all income levels. The reasons for such variation are poorly understood but are likely due to a wide range of structural factors that affect road safety outcomes. It would be much more useful to understand why countries at the same income level perform very differently than to understand the relationship of road safety performance with income (Bhalla and Mohan 2016).

Relative risk of different category of road users in different societies

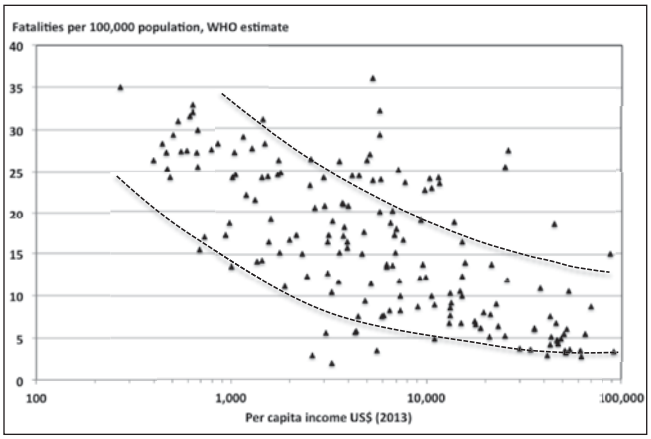

Figure 2. Estimated fatalities per 100,000 population (WHO estimates) vs. national per capita income for 171 countries. Source (WHO 2015)

Almost all our understanding of road safety issues derives from the experience of about a hundred years of motorisation in the high-income countries of today. This experience is based on traffic systems where the safety of car occupants remained the central concern. In these countries cars have been the dominant part of traffic systems unlike in many of the LMIC where MTW and paratransit vehicles like three-wheeled taxis, tuk-tuks, jeepeneys (TWT in this paper) constitute a significant proportion of traffic on roads. Since we do not have detailed epidemiological studies on the effect of these latter vehicles on traffic safety in LMIC we do not have a good understanding of the risks faced by occupants of these vehicles where these vehicles form a dominant mode of transport. Here data available from research reports originating from India are compared with the experience of OECD countries to get an initial understanding of the differences in traffic safety issues around the world.

Relationship between MTW share in vehicle fleet and fatalities

Figure 3 shows the percentage of motorised two-wheeler (MTW) fatalities in OECD countries for the years 2001 and 2011 and Indian cities in 2013 vs. the percentage of MTW in fleet (OECD/ITF 2015; Jacobsen 2015). Data for countries is not strictly comparable with urban data as vehicles on urban roads may operate under different conditions than those on rural roads. However, these data do provide us with some pointers for further study. These data show that though there is a general tendency for the proportion of MTW fatalities to increase with an increase in the proportion of MTW in the fleet, the relationship is not very strong.

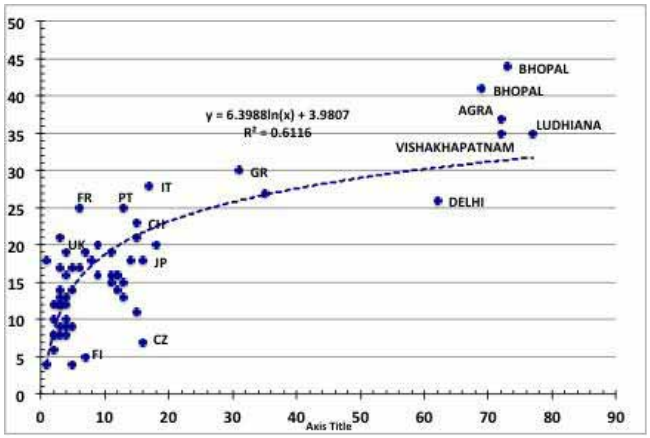

Figure 3. Per cent motorised two-wheeler (MTW) fatalities in OECD countries (no labels) for the years 2001 and 2011 and Indian cities (with labels) in 2013 vs. per cent MTW in fleet (Data from Bhalla and Mohan 2016; OECD/ITF 2015)

For example, in 2011 Finland, Japan and Switzerland had similar proportions of MTW in their fleets (13%, 14% and 15% respectively) but MTW fatality shares were very different at 13%, 18% and 23% respectively (OECD/ITF 2015). In the six Indian cities the share of MTW in the fleet is similar, but proportion of MTW fatalities differ substantially.

The explanations for differences in MTW fatalities could include differences in driving speeds, distance driven per year, helmet use, dominant age group using MTW, and engine size of MTW. The data also show that the safety in numbers effect may be true for MTW riders also as MTW fatalities do not seem to increase in proportion to MTW in the fleet, especially when MTW proportions are high. Safety in numbers is the phenomenon by which the per road user frequency of being killed declines as the proportion of those road users increase in a city or country (Jacobsen 2015; Beanland et al 2014).

Fatality rates for different vehicle occupants in OECD countries and Indian cities

Table 1 shows data for selected OECD countries for fatalities of MTW and car occupants per billion vehicle kms. Car occupant fatality rates range from a low of 2.1 in the United Kingdom to a high of 10.5 in the Czech Republic, and, for MTW riders from a low of 39 in Switzerland to a high of 253 in the Czech Republic. There are no clear explanations available why car occupant risk rates differ by a factor of five and MTW rates by a factor of six in these OECD countries.

Figure 4. Example of a three-wheeled scooter taxi (TWT)

Table 1. MTW and car occupant fatalities per billion vehicle km in OECD countries (Data source: OECD/ITF 2015)

Country	Fatalities/billion vehicle km		MTW/ Car Radio
	MTW	Car	
Australia	71.8	5.2	14
Austria	59.7	4.7	13
Belgium	76.9	5.9	13
Canada	62.9	4.9	13
Czech Republic	252.6	10.5	24
Denmark	49.5	4.2	12
France	72.4	4.9	15
Germany	59.5	3.3	18
Ireland	60.8	2.5	24
Israel	45.7	5.1	9
Netherlands	64.0	3.0	21
Slovenia	112.5	4.3	26
Sweden	43.9	2.2	20
Switzerland	39.2	2.3	17
United Kingdom	72.0	2.1	34
United States	155.0	5.0	31

The last column in Table 1 gives the ratio between car and MTW fatality rates per billion vehicle kms for each country. In Israel MTW riders have nine times higher risk of dying than car occupants and in United States this ratio is 31.

Table 2 shows estimates of fatalities of MTW, TWT and car occupants per billion vehicle kms for selected Indian cities (Mohan et al 2016; Mohan et al 2014). These data are not available at the country level. Vehicle mileage data for Delhi and Vishakhapatnam were obtained from special surveys (Mohan et al 2014). Vishakhapatnam vehicle-use data were used for other cities as they are similar in size. TWTs are paratransit vehicles used as taxis and an example is shown in Figure 4. Helmet use is compulsory for all MTW riders by law in India (Ministry of Road Transport and Highways 1988) but out of the six cities included in Table 2 the law is being enforced only in Delhi with compliance rates around 90% in the daytime (Patel and Mohan 1993), which may explain the relatively low fatality rate in Delhi. Agra has the highest fatality rates for the three categories of vehicles compared to the other cities. The reasons for this are not known.

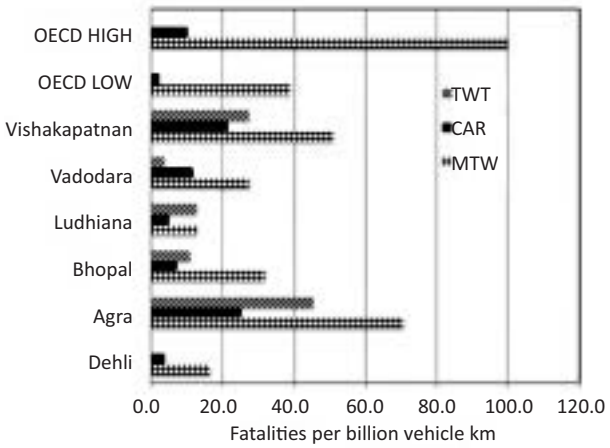

Figure 5. Fatalities per billion vehicle km on OECD countries and six Indian cities for MTW, TWT and cars.

The fatality rates per billion vehicle kilometres for each category of vehicles differ by more than a factor of five. The differences among these cities are similar in magnitude as those observed for OECD countries. Detailed epidemiological data are not available at present to account for these differences. It would be very useful if data are obtained to understand the reasons for the differences between high rate and low rate cities for each category of vehicles.

OECD country and Indian city comparison of fatality rates per billion vehicle km for cars.

The fatality rates per billion vehicle kms for selected OECD countries for cars and MTW and the ratio of MTW and car rates are given in Table 1 and the rates for MTW, cars and TWT along with MTW/car and TWT car ratios in Table 2. Figure 5 compares the rates in Indian cities with the highest and lowest rates in OECD countries. Though country and city data are strictly not comparable we think that comparison of these statistics will give us leads for greater examination of these issues.

The average fatality rate for car occupants in six Indian cities is 4.9 fatalities per billion vehicle km with a high of 25 and low of 3.8. The average for OECD countries is 4.4 fatalities per billion km with a high of 10.5 and low of 2.1. The highest and lowest values differ by a factor of about five for both the groups.

Table 2. MTW, TST and car occupant fatalities per billion vehicle km in selected Indian cities (Data source: Bhalla and Mohan 2016; Beanland et al 2014)

Indian city	Fatalities/billion vehicle km			MTW/ Car Radio	TWT/ Car Radio
	MTW	TWT	Car		
Australia	71.8	-	5.2	14	-
Austria	59.7	45.3	4.7	13	1.8
Belgium	76.9	11.1	5.9	13	1.5
Canada	62.9	12.8	4.9	13	2.6
Czech Republic	252.6	3.8	10.5	24	0.3
Denmark	49.5	27.4	4.2	12	1.3

In OECD countries, all cars are required to conform to crashworthiness standards; and seat belt wearing rates in a majority of the countries are more than eighty per cent (IRTAD 2014). In contrast, cars in Indian cities do not have to conform to crashworthiness standards (Mohan et al 2015) and seatbelt use is likely to be less than twenty per cent overall, as the law is applicable only to front seat passengers and not enforced strictly except in Delhi during daytime (Mohan 2009). Use of seat belts by drivers, front seat passengers and rear seat passengers is expected to reduce fatalities by 50%, 45% and 25%, respectively (Elvik and Vaa 2004). According to Farmer and Lund (Farmer and Lunk 2015), between the years 1984 and 2009 the risk of driver death declined by an estimated 42% in cars, 44% in pickups, and 75% in SUVs in USA. Therefore, we should expect fatality rates of car occupants in Indian cities to be about double those in the OECD countries with better safety records, based on this factor alone. Average country fatality rates for vehicles can be higher than city rates due to lower average velocities in the latter, therefore it is possible that the car fatality rate per billion vehicle km is higher than the average city rate quoted above. However, it appears that the highest and lowest fatality rates for cars on an average in India are about double those in the OECD countries. If all cars in India satisfied the NCAP crashworthiness norms we could expect a reduction in fatalities by more than 50%. It is estimated that car occupant fatalities in India are about 10,000-13,000 (7%-9%) of the total of 141,526 fatalities. Therefore, if all cars in India had similar crashworthiness characteristics as those in OECD countries in 2014 and seat belt laws were being enforced, we would at least halve the annual car occupant fatalities and save about 5,000-6,000 (~4%) lives annually. At present growth rates it will take about 15 years for ninety per cent of the car fleet to be replaced in India (Mohan et al 2014). Therefore, while it is imperative that all cars in India satisfy international crashworthiness standards, it will only result in a reduction of death rates by less than 4% over the next 15 years.

OECD country and Indian city comparison of fatality rates per billion vehicle km for motorised two-wheelers.

The average fatality rate per billion km for MTWs in the selected OECD countries is 81.2 with the lowest being 39.2 and the highest 252.6. The average rate for the six Indian cities is 21.3 with lowest being 12.8 and highest 70.7. The lowest fatality rate in Indian cities is about one third of the lowest rate in OECD countries and the highest in India slightly more than one third of the highest in OECD countries. The much lower rates in Indian cities are probably partly due to lower powered MTWs (most have engines < 175 cc), lower velocities in urban areas, and because MTWs in Indian cities tend to be used by an older age group for regular urban commuting and less for sporting or recreational purposes. However, differences in

rates by a factor of three probably cannot be explained by these issues alone.

Use of daytime running lights by MTWs is negligible in all Indian cities and the helmet law enforced only in Delhi among the cities included in Table 2. Helmet laws are expected to reduce fatalities by about thirty to forty per cent (Elvik and Vaa 2004; Cochrane database 2003) and daytime running lights on MTWs by about fifteen per cent in tropical countries (Radin 1996; Yuan 2000). Therefore, if daytime running lights were in use in India and helmet laws observed by all MTW riders, the fatality rates may have been lower by 40%-50%. In that case the Indian city MTW fatality rates would be about five times lower than the OECD country MTW rates. The ratio of risk for MTWs compared to cars range from 2.3 to 4.4 for Indian cities and 9 to 34 for OECD countries. Such a large difference in MTW risks and risk ratios cannot be explained by knowledge presently available with us.

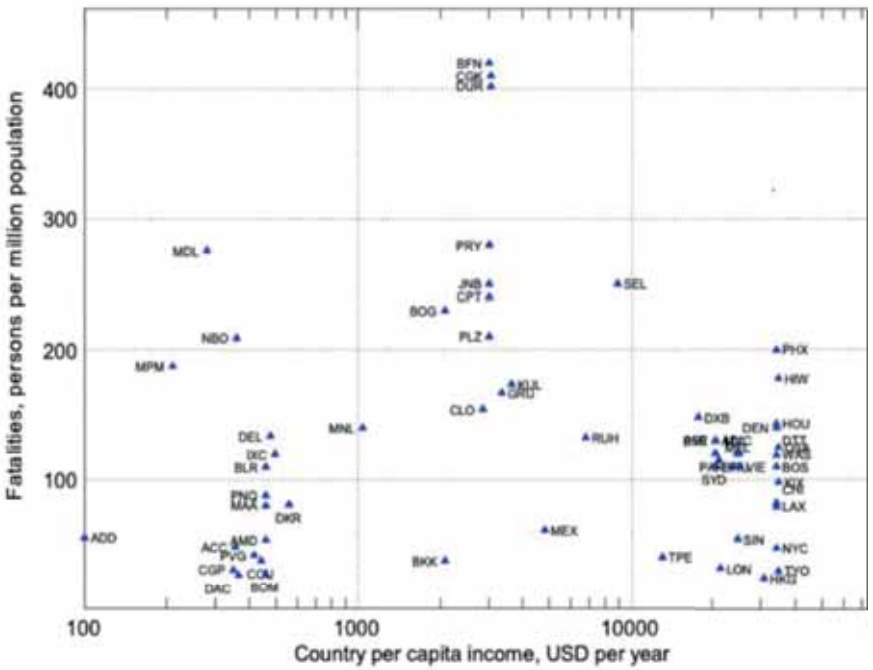

Figure 6. Fatality risk in traffic crashes by city. Cities are represented by their respective airport codes (Airport codes in Appendix 1, Source: Gadapalli and Rajkotia 2012)

According to recent estimates MTW fatalities constitute 20%-34% (~29,000-49,000 fatalities) of the total fatalities in India (Mohan 2015). Daytime running lights and helmet use can be enforced almost immediately and would reduce fatalities by about 12,000 to 20,000 lives annually. This is a saving of lives greater than 3-5 times than ensuring crashworthiness of cars and use of seat belts.

Comparison of fatality risk of occupants of three-wheeled taxis with that of car occupants in Indian cities

The fatality rates of TWT occupants per billion vehicle km range from 0.3 times to 2.6 times that for car occupants. The average occupancy of cars ranges from 1.8 to 2 and that of TWTs from 3-8 (Mohan et al 2016; Arora and Jawed 2011; Gadapalli 2016; Chanchani and Rajkotia 2012). Since the average occupancy of TWTs can be more than two times that of cars, and the fatality rate of TWT occupants per billion km less than twice that for car occupants, the risk of fatality per passenger km for the two vehicles could be similar. This is a very surprising finding because TWTs weigh less than a third of cars (Gawade 2004), have no surrounding steel shell and have to subscribe to a minimum of safety standards. Studies comparing safety of large cars with small cars have consistently found that larger cars provide better protection than small cars (Broughton 2008; Wood 1997; Buzeman et al 1998). All these studies have been done in high-income countries where all cars are capable of similar driving speeds.

No previous studies are available on safety records of motor vehicles that are not capable of high speeds operating in mixed traffic in urban areas. TWTs operating in Indian cities have engines smaller in size than 175 cc and generally cannot exceed velocities greater than 50 km/h. The experience of TWTs in Indian cities suggests that small lightweight vehicles with limited speed capabilities operating in the urban environment can result in low occupant fatality rates. The lower operating speed of TWTs also implies that they pose a much lower risk to pedestrians, bicyclists, and other road-users. This issue needs to be studied in greater detail, and if found true, it may suggest that there may be a need for less severe crashworthiness standards for such vehicles as compared to those capable of higher operating speeds.

Urban form and traffic safety

Figure 6 shows road traffic fatalities per million population for 56 cities around the world (Mohan 2008). These data show that there are wide variations across income levels and within similar income levels. The fatality rate varies by a factor of about 20 between the best and the worst cities. Some characteristics are summarised below:

- Overall fatality risk in cities with very low per-capita incomes (less than USD 1,000) and those with high incomes (greater than USD 10,000) seems to be similar.
- There is a very high variability in fatality risk in middle income countries (USD 10,000-20,000).
- There is a great deal of variation even in those cities where the per capita income is greater than USD 20,000 per year.

These patterns appear to indicate that it is not sufficient to have the safest vehicle technology to ensure low road traffic fatality rates uniformly across cities in those locations. Even in low and middle-income countries, the absence of funds and possibly unsafe roads and vehicles does not mean that all cities have high overall fatality rates. It is possible that the numbers reported for some of the low income cities may be underestimates. Provision of safely designed roads and modern safe vehicles may be a necessary condition for low road fatality rates in cities, but not necessarily a sufficient one. The fact that there are wide variations for overall fatality rates among high income cities, where availability of funds, expertise and technologies are similar, indicates that other factors like land use patterns and exposure (distance travelled per day, presence of pedestrians, etc.) may play an important role also.

Various studies suggest that (Dumbaugh 2013; Ewing and Dumbaugh 2009; Mohan and Bengdiwala 2013; Clifton et al 2009; Gronlund 2013; Risom and Mookerjee 2013; Hanson et al 2013; Marshall and Garrick 2011):

- Fatality rates in cities are not solely determined by income levels or city size. RTI fatality rates among cities with similar incomes or similar population levels can vary by a factor of 3-5. This indicates that city street structure and urban form can have a very significant effect on RTI fatality rates over and above issues of vehicle design and enforcement.
- It may be more useful to compare cities with very different RTI fatality rates rather than taking all cities in the sample to tease out the real factors influencing road safety.
- Cities with a higher proportion of wide streets and low density road networks appear to have a much higher RTI fatality rate.
- Urban form and street design patterns may have to be given much more importance to improve safety of pedestrians, bicyclists and transit users.

This suggests that we must spend more time in understanding the role of urban design and its influence on traffic safety as the present knowledge is inadequate.

Conclusions

In this paper, data available from published reports are examined to understand the shortcomings in our present understanding of road safety issues in low and middle-income countries. It is possible that there is not necessarily a relationship between income and road safety performance as there is a very large variation in road safety performance of countries at the same income level. This is true for countries at all income levels. The reasons for such variation are poorly understood but are likely due to a wide range of structural factors that affect road safety outcomes. It would be much more useful to understand why countries at the same income level perform very differently than to understand the relationship of road safety performance with income. Some of the issues that need much greater understanding is the safety performance of motorised two-wheelers and para transit vehicles in low and middle income countries and the effect of urban form on road safety.

The data analysed show that though there is a general tendency for proportion of MTW fatalities to increase with increase in proportion of MTW in the fleet, the relationship is not very strong. The data also show that a "safety in numbers" effect may exist for MTW riders also as MTW fatalities do not seem to increase in proportion to MTW in the fleet, especially when MTW proportions are high.

Focussing solely on car occupant safety is not likely to make a substantial dent in fatalities in low income countries. In India, car occupants comprise less than 10% of all deaths. Therefore, while it is imperative that all cars in India satisfy international crashworthiness standards, this will only result in a reduction of death rates by less than four per cent annually over the next 15 years.

MTW safety in India seems to differ substantially from that in OECD countries. The risk statistics for MTWs compared with cars range from 2.3 to 4.4 for Indian cities and 9-34 for OECD countries. Such a large difference in MTW risks and risk ratios cannot be explained by knowledge presently available with us. Daytime lights and helmet use can be enforced almost immediately and would reduce fatalities by about 50 per cent – about 12,000 to 20,000 lives annually. This is a saving of lives greater than 3-5 times than ensuring crashworthiness of cars and use of seat belts.

The risk of fatality per passenger for cars and para transit vehicles like TWTs and cars seems to be similar in India. This is a very surprising finding because TWTs weigh less than a third of cars, have no surrounding steel shell and have to subscribe to a minimum of safety standards. The experience of TWTs in Indian cities suggests that small lightweight vehicles with limited speed capabilities operating in the urban environment can result in low fatality rates. This issue needs to be studied in greater detail, and if found true, it may suggest that there may be a need for less severe crashworthiness standards for vehicles with operating speeds much lower than standard cars.

International data on fatality rates in cities show that there are wide variations across income levels and within similar income levels. The risk varies by a factor of about 20 between the best and the worst cities. These patterns appear to indicate that it is not sufficient to have the safest vehicle technology to ensure low road traffic fatality rates uniformly across cities in those locations, and urban form and street structure may have a significant effect on road traffic fatality rates. Since urban growth is going to continue in low and middle income countries it is very important that we develop a clearer understanding on what kind of city forms will ensure safe travel patterns.

Promoting a few well-known safety countermeasures like helmet and seat belt use; weak efforts at controlling speeds and drinking and driving; and crashworthiness standards

for cars may not be enough for lowering road traffic fatality rates internationally. Much more detailed research needs to be done in low and middle-income countries by establishing research centres in these countries. Researchers in these centres would have to focus on the differences in patterns of crashes of the kind outlined in this paper and determine the underlying causes for the same. This would go a long way in helping achieve the objectives of the UN Decade for Road safety.

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Appendix 1

CODE	CITY	CODE	CITY	CODE	CITY
ACC	Accra	DEL	Delhi	MEX	Mexico City
ADD	Addis Ababa	DEN	Denver	MNL	Manila
ADL	Adelaide	DKR	Dakar	MPM	Maputo
AMD	Ahmedabad	DTT	Detroit	MUC	Munich
BER	Berlin	DUR	Durban	NBO	Nairobi
BKK	Bangkok	DXB	Dubai	NYC	New York City
BNE	Brisbane	GRU	Sao Paulo	PAR	Paris
BOG	Bogota	HIW	Honolulu	PEK	Beijing
BOM	Mumbai	HKG	Hong Kong	PHX	Phoenix
BOS	Boston	HOU	Houston	PNQ	Pune
BRU	Brussels	IXC	Chandigarh	PRY	Pretoria
CCU	Kolkata	JNB	Johannesburg	RUH	Riyadh
CGK	Jakarta	KIX	Osaka	SEL	Seoul
CGP	Chittagong	KUL	Kuala Lumpur	SIN	Singapore
CHI	Chicago	LAX	Los Angeles	TPE	Taipei
CLO	Cali	LON	London	TYO	Tokyo
CPT	Cape Town	MAA	Chennai	VIE	Vienna
DAC	Dhaka	MEL	Melbourne	WAS	Washington

Malaysian road fatalities prediction for Year 2020

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Abstract

Fatality reduction is crucial in road safety management. This paper illustrates fatality models developed in Malaysia in predicting the number of fatalities since the early 1990's to the current figures. All models were based on statistical models, utilising linear models, log linear and time series. The objective of this paper is to highlight the recent road fatalities model, using ARIMA models that have been developed and used by government agencies in planning for road fatality reduction.

Keywords

Road fatalities, Time series, ARIMA

Introduction

The United Nations in the 2030 Agenda for Sustainable Development had highlighted one of the goals which relate to road safety; to halve the number of global deaths and injuries from road traffic accidents by the year 2020. In the year 2013, 1.25 million deaths were recorded globally, and most of these deaths occurred in the low- and middle-income countries (World Health Organization, 2015). Malaysia, as one of the developing countries, has acknowledged road safety as a critical problem that should be addressed. In the 80's, Malaysia recorded an average of 4% annual increment of road traffic fatalities, followed by 5% in the 90's. However, the figure increased at a slower rate of 2% in more recent years (2000–2009) (Rohayu, Allyana , & Wong, 2012). Even though the trend recorded smaller increments over the last nine-year period, the real number of fatalities is increasing. In 2010 alone, 6,872 fatalities were recorded (PDRM, 2011) a 1.8% increase from the previous year (2009: 6,745).

It is often said that if we fail to plan, we are planning to fail. In recent years, the Malaysian government has been actively taking serious steps in reducing road fatalities. Back then in the year 1990, after the Karak crash, which claimed 15 deaths including army personnel, the Cabinet Committee on Road Safety was formed. The Committee set a target of 30% reduction in road deaths by the year 2000. It was based on predicted deaths made by Radin's model (Sohadi, 1998). Through the Ministry of Transport, the Road Safety Department introduced the first Road Safety Plan of Malaysia 2006-2010 (Road Safety Department, 2006). This plan outlined nine strategies to reduce road fatalities through the five-year period. Another target was set up to be achieved by the year 2010. The target was based on a fatality index, similar to indices used in developed countries. It was outlined that by the year 2010, deaths per 10,000 vehicles should reduce to 2.0, and deaths per 100,000 population should reduce to 10. The basis of the target was explained in detail by Law et. al (Law, Radin Umar, & Wong, 2005). Since the last model developed in the year 2005, Malaysia has been focusing on the implementation of road safety initiatives. The establishment of the Malaysian Institute of Road Safety Research (MIROS) in the year 2007 showed government commitment in combating road deaths. As a research institute dedicated for road safety, MIROS established a prediction model to predict road fatalities.

The objective of this paper is to present the current prediction model. As the model developed by Law et al was in the year 2010, there is a need to revise the current state of road safety in Malaysia and establish with the new prediction model. The second Malaysian Road Safety Plan 2014 – 2020 was produced in the year 2014 (Road Safety Department, 2014). The target for year 2020 was based on the predicted number of deaths in the year 2020 (Rohayu, Allyana , & Wong, 2012), which was set to reduce the number of deaths to 5,358. Therefore, it is important to review the model after the year 2015 and develop a new forecast to the year 2020.

Literature Review

Various fatality models have been developed for Malaysian road accident deaths, and used in the national road safety plan. Early works of modelling road deaths in Malaysia started with the development of a simple linear model (Aminuddin, 1990). In the mid-nineties, Karim (Karim, 1995) proposed an improved model, with more predictors. From the model, Karim projected 5,067 deaths in the year 2000, with estimated exposures of a population of 23 million and 10 million vehicles by the year 2000. Radin and Hamid (Radin Umar & Hamid, 1998) proposed that the rate of infrastructure growth in both roads and highways are highly correlated (r= 0.95). In light of improving the model, Radin (Radin Umar, 1998) added two explanatory variables: road length and the effect of standardised accident data.

Radin's model developed in the year 1998 has become part of input in preparing Malaysia's road safety target for year 2000. Radin's model predicted that the number of fatalities for the year 2000 was 9,127. In the year 1998, the number of deaths recorded was 5,740. In the year 1996, Malaysian government established a five-year national road safety target of 30% accident reduction by year 2000. Hence, using Radin's model which predicted 9,127 deaths in the year 2000, Malaysia planned for a 30% reduction target,

Table 1: Fatality models in Malaysia

Author / Year	Predictor Variables	Prediction Model	Predicted fatalities (Year)	Target deaths as set by Road Safety Plan of Malaysia	Actual deaths (Year)
Radin /1998	Population, Number of vehicles, Road length, Effect of standardized accident data	Death = 2289 (exp $^{0.00007veh.pop.road}$) (exp $^{0.2073\ data\ system}$)	9,127 (2000)	6,389	6,035 (2000)
Law et.al / 2005	Vehicle ownership rate	Gompertz Growth ARIMA model	4 deaths per 10,000 vehicles (2010)	4 deaths per 10,000 vehicles	3.4 deaths per 10,000 vehicles (2010)
Rohayu et.al/2012	Annual death series	ARIMA model	10,716 (2020)	5,358	6,674 (2014)

equivalent to 6,389 deaths. In the year 2000, the actual number of deaths was 6,035.

By comparing the actual figures in 1998, and the predicted deaths in the year 2000, the difference is quite significant (difference by 3,387 or 60% increment from the 1998 figure) despite the short time frame. The prediction was based on the growth of population, vehicles, road length and inclusion of accident data from Sabah and Sarawak.

Law et al. (Law, Radin Umar, & Wong, 2005) predicted road accident deaths in the year 2010 by making the projection for the vehicle ownership rate in the year 2010. The study used the Gompertz growth model, proposed by Dargay and Gately (Dargay & Gately, 1997) to project vehicle ownership as a function of per capita Gross Domestic Product (GDP), and Autoregressive Integrated Moving Average (ARIMA) to predict the road accident death rate.

Table 1 summarises fatality models developed in Malaysia, including the latest model.

The time series approach has been used in road safety fields, but mostly to evaluate road safety interventions. For example, Forester, McNown and Singell (Forester, McNown, & Singell, 1984) evaluated speed limit changes, and Garbacz and Kelly (Garbacz & Kelly, 1987) used log linear time series model to evaluate the safety impact of vehicle inspection. In forecasting, Raeside and White (Raeside & White, 2004) used monthly data on fatal and seriously injured victims in traffic crashes in Great Britain. However, the limitation of the data makes their forecasts less reliable as they used eight years of data to forecast for another 10 years ahead. Raeside (Raeside, 2004) then used annual data from 1970 to 2002, employing an autoregressive error model with lagged dependent variables, and forecast fatalities in 2010.

Methodology

The prediction of Malaysian road deaths for the year 2020 was based on a time series model; namely the ARIMA model. The figure for road traffic fatality is based on the official road death fatalities figure reported by the Royal Malaysian Police (PDRM). This annual figure is obtained from the Annual Road Traffic Report. In Malaysia, fatalities are defined as any person who died within 30 days as a result of accident (Royal Malaysian Police 2009). Data is available from 1972 to 2010 (39 annual number of deaths) and contains all road traffic fatalities from all 14 states in Malaysia. In developing the ARIMA model, data from 1972 to 2006 (36 observations) was used. The model developed was used to forecast for year 2007 to 2020 (14 observations).

There are many time series models that cater for different data type and structure, depending on the nature of data. Among the popular time series models is the Box-Jenkins approach, which is synonymous with ARIMA modelling. Auto-Regressive Integrated Moving Average (ARIMA) was developed by Box and Jenkins (Box, Jenkins, & Reisel, 1994), and has been widely used in road safety research. ARIMA modelling is usually applied to time series analysis, forecasting and control. The term ARIMA is a combination of Auto Regressive (AR) Integrated (I) Moving Average (MA) models. There are three stages in developing ARIMA models: model identification, model estimation and model validation. The process of model estimation and validation is iterative, until the best model is found.

The Box-Jenkins model used in the first phase consisted of the autoregressive model (AR), moving average (MA) model and Autoregressive-moving Average (ARMA) models. In the Autoregressive model, the dependent variable, Y_t is defined as a function of its previous value or historical value plus an error term. The Moving Average (MA) model links the current value to random errors that have occurred in the previous periods rather than the actual series themselves (Mohd Alias, 2007). The acronym ARIMA stands for "Auto-Regressive Integrated Moving

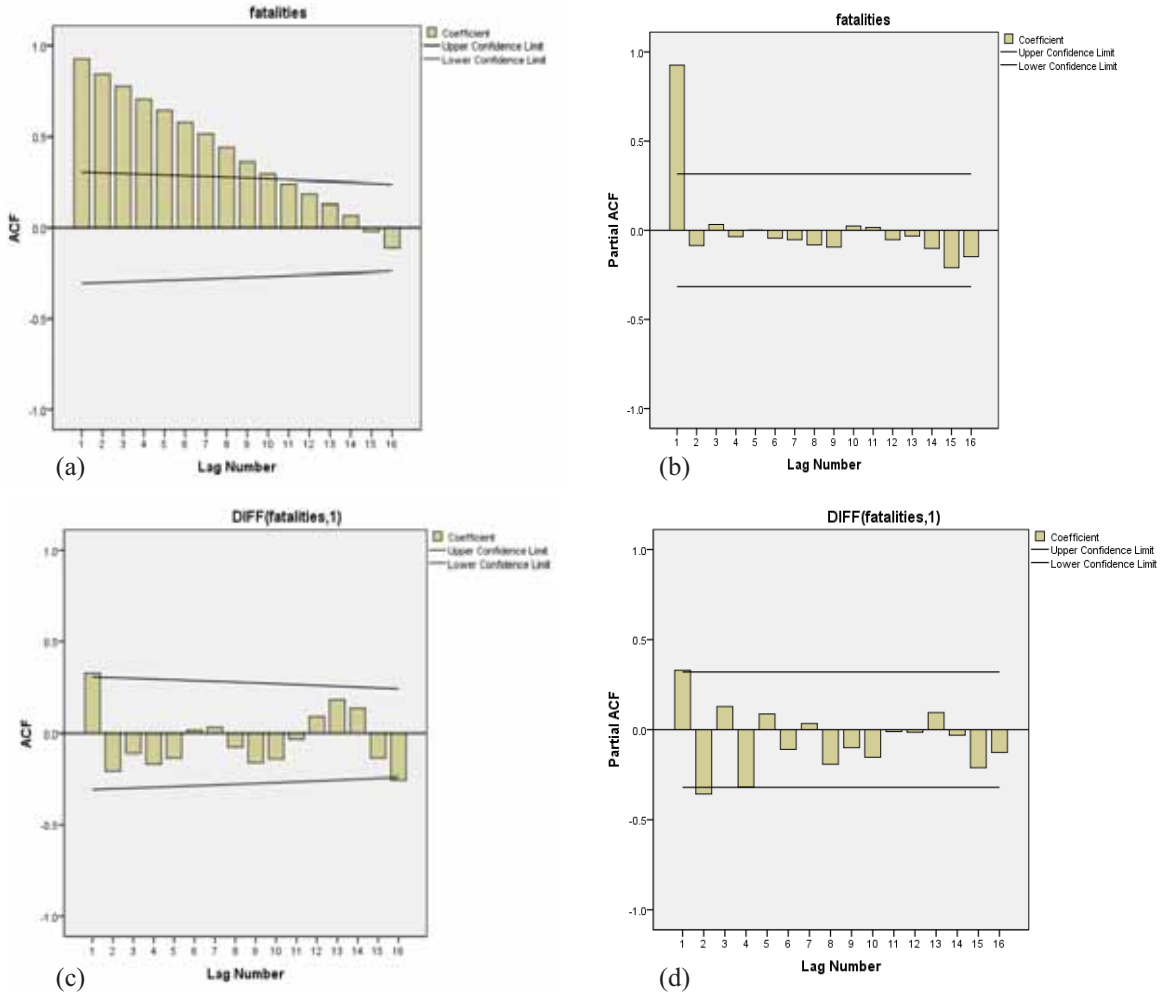


Figure 1: (a) and (b) are correlograms of ACF and PACF of original series, (c) and (d) are correlograms after the first differencing

Average." Lags of the differenced series appearing in the forecasting equation are called "auto-regressive" terms, lags of the forecast errors are called "moving average" terms, and a time series which needs to be differenced to be made stationary is said to be an "integrated" version of a stationary series.

The hardest part in Box Jenkins methodology is to identify which model really describes the data. The identification of the correct model starts with inspecting the autocorrelation coefficients (ACs) and Partial autocorrelation coefficients (PACs). These two measure the degree of interdependence among the observations in the series. In other words, the ACs and PACs measure the degree of interdependence between current and past fatalities figures.

Based on correlograms of ACF and PACF (Figure 1(a) and 2(b)), the most suitable model is identified and further analysis on model fit is conducted. From the correlogram of ACF, the sample ACF values are large and decline rather slowly to zero, therefore it can be concluded that the original series of road fatalities is not stationary. The PACF correlogram, shows that there is a significant large spike at Lag 1, followed by smaller other spikes. These suggest that the original fatalities series can be made stationary after performing the first difference. After inspecting ACF and PACF of original series, it is concluded that no seasonal variation exists in the series. Therefore, a non-seasonal ARIMA should be considered. The ACF and PACF suggest that ARMA (p,d,q) model should be used. The fatalities series is now stationary after the first difference (Figure 1(c) and 2(d)).

ARIMA uses past values and past errors to detect patterns and predict future values. A simple ARIMA (0,1,1) with constant is expressed as below:

$$\hat{Y}_t = \mu + Y_{(t-1)} - \theta\varepsilon_{(t-1)} \ldots\ldots\ldots\ldots\ldots \text{Equation (1)}$$

A non-seasonal ARIMA model is classified as an "ARIMA (p,d,q)" model, where:

- p is the number of autoregressive terms,
- d is the number of non-seasonal differences, and
- q is the number of lagged forecast errors in the prediction equation.

The next step is to identify which ARIMA (p,d,q) suits the data best. A list of models to be considered were tested for model fit and error rate employing Expert Modeller function in SPSS version 20.0.

Table 2: Parameter Estimates for ARIMA (0,1,1)

Variable	Parameter estimate	Standard error	t-statistics	Significance value
Constant	0.036	0.016	2.226	0.033
Fatalities (MA Lag 1)	-0.901	0.117	-7.712	0.000

Results

The study uses the ARIMA model in predicting Malaysian fatalities for year 2020, by using historical data from year 1972 until year 2010. Data from year 1972 to 2006 was used in model development and the rest were used as model validation. Results showed that R-squared value is 0.981, really close to 1, indicating that the model is able to explain 98% of variation in the data. Ljung-Box statistics also showed that the error of the model is not correlated. Fatalities for year 2015 and 2020 are 8,760 and 10,716 respectively, for business as usual (BAU) scenario.

The best ARIMA model produced from the data is ARIMA (0,1,1). Table 2 shows parameter estimate for ARIMA (0,1,1) based on Malaysia road deaths annual data. The ARIMA (0,1,1) model with constant has the prediction equation:

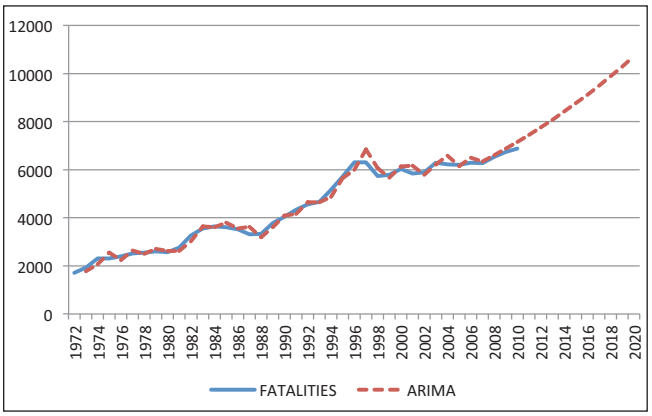
$$\widehat{Y}_t = \mu + Y_{(t-1)} - \theta\varepsilon_{(t-1)}$$

Where Y_t is fatalities at current time, t, $Y_{(t-1)}$, is fatalities a year before, and θ = -0.901

For model fit, R-squared value for ARIMA (0,1,1) is 0.981, in other words, the model suits the data. Ljung Box statistics, which provides an indication of whether the model is correctly specified, Hypothesis is accepted, as the Ljung Box statistics = 0.938 is more than alpha = 0.05. This indicates that residuals of ARIMA models have no auto correlation.

Figure 2 illustrates the original fatalities series as compared to ARIMA model. The solid line indicates the annual number of deaths recorded from the year 1972 to year 2010. On the other hand, the dotted line shows forecasted number of deaths by using ARIMA model. It shows that ARIMA follow closely to the series at the beginning of the forecast. The forecasted figure did not differ much from the original series, up to the year 2010. For each additional year, the predicted figure deviates further, as it forecasted based on historical data.

Figure 2: Fatality forecast for Malaysia



Discussion

Road fatalities prediction is important in this target setting exercise. Utilising a sound predicted figure allows government to intervene by implementing various initiatives to deliver target improvements. In Malaysia alone, there are several models proposed and applied to government since the year 2000. Expected numbers of deaths can be used to establish a national target to offset the rising number of road deaths.

In comparison with other models developed for Malaysia, this univariate ARIMA model, used historical data to predict future road deaths. Adding more variables to the model would allow for sensitivity analysis, but it will require more estimation for each variable, adding risk to accuracy of estimates. For example, if population, road length and GDP were to be added to the equation to predict the number of fatalities, an estimated figure of population, road length and GDP for the year 2020 is needed as an input to the equation, before the number of fatalities could be obtained. Hence, the process would have introduced more errors due to multiple estimations of the independent variables.

One of the important issues in forecasting is to understand the forecast horizon. Forecast horizon means the time frame in which the forecast is valid. In this case, the forecast horizon refers to the year 2011 until 2020. ARIMA model uses historical values. The accuracy of predicted values may be compromised as the forecast horizon becomes longer. This is one of the disadvantages of the model. To overcome this, as new data is available, a new ARIMA model should be developed to generate new forecast figures. Hence, it is important to review the model after the year 2015 and develop a new forecast to the year 2020.

Another important issue is that ARIMA model is sensitive to any structural change. Structural change in road safety may include but is not limited to, the introduction of new effective laws and implementation of new interventions such as an Automated Enforcement System. Such structural changes can have a lagged effect on the series. For instance, if an intervention is introduced in the year 2013, the effect may be seen two years later, which may require the model to be updated depending on the level of impact of the new intervention. In developing the ARIMA model in the study, the author assumes that Business As Usual, which means that if there is no new intervention, the number of deaths will remain at 8,760 for the year 2015 and 10,716 death in the year 2020. Of course, the Malaysian government will push for more interventions to offset the number of deaths, and the model provides a baseline for assessment of disruptive change.

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A resource allocation model for traffic enforcement

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Abstract

A method has been developed to estimate the crash reduction benefits of increases in each type of traffic enforcement applied to an appropriate road environment. This method has been based on numerous studies linking enforcement levels with road crashes and/or injury severity in the Australian States and internationally. Economic analysis of the crash savings and costs from investment in each type of traffic enforcement has shown that mobile speed cameras and random drug tests provide the highest benefit-cost ratios.

Introduction and approach

A review of strategic approaches to choosing packages of road safety initiatives, including enforcement programs, concluded that greatest economic value is obtained from packages in which the components have marginal benefits (from reductions in road trauma) greater than marginal costs (Diamantopoulou, Clark and Cameron 2009). Traffic enforcement initiatives with variable levels of intensity should be analysed to decide the appropriate types and levels of operation for inclusion in an overall program.

A Traffic Enforcement Resource Allocation Model (TERAM) was developed to guide allocation of Police resources regarding the enforcement of speeding, drink-driving and drug-driving in Victoria. The first step was to document the research and relationships connecting levels of traffic enforcement of each type with reductions in road trauma measured by crash frequency and/or the injury severity of crash outcomes. Evaluations of each enforcement type were summarised by meta-analysis (Christensen 2003) to provide an overall estimate of the key parameter of the relationship connecting the enforcement with road trauma reductions.

The intensity of some enforcement types, usually mobile operations, can be measured by operational hours, vehicles or drivers assessed, or number of infringements detected and prosecuted. In contrast, the intensity of fixed operations, usually camera-based, is principally measured by the number of sites covered (within an enforcement halo) as well as the other measures. The effect of fixed camera-based operations on road trauma is related to the number of sites and the crash reductions at each individual site.

The next step was to estimate the costs per unit of intensity of each traffic enforcement type, covering equipment capital cost and maintenance, person operating costs, and costs of offence processing. The final step was to compare the social cost value of the reduction in road trauma at each level of intensity of each enforcement type with the total cost of offence detection and processing at that intensity level. The economic value of each enforcement type and intensity level was assessed by its benefit-cost ratio, both for the full increase from its current level and at the marginal level for the next unit increase in intensity.

Relationships between traffic enforcement intensity and road trauma

Background

Elvik (2001) has developed a general framework for the cost-benefit analysis of police enforcement. A key part of this framework is the relationship between changes in the level of police enforcement and changes in crashes, measured by the percentage reduction in crashes or relative risk, relative to a base level.

After reviewing a large number of studies of the effects of varied levels of traffic enforcement on casualty crashes, Elvik (2001) concluded that the relationship is of the form shown in Figure 1. Even for the most effective forms of enforcement, the relationship with crash reductions is not linear. Diminishing returns apply as the level of enforcement increases. However, within the range of increases observed in the studies (up to 10-12 fold), it appears that at least some crash reductions occur for each increase in enforcement effort.

Elvik (2001) proposed a number of potential functional forms for the relationship shown in Figure 1. Perhaps the most suitable is the power function:

$$Y = A \cdot X^B$$

where Y is the number of casualty crashes, X is the level of enforcement, and A and B are parameters related to the

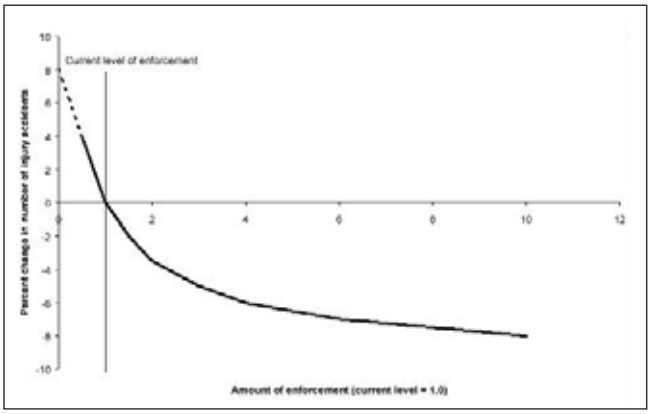

Figure 1: General relationship between traffic enforcement and crashes (Elvik 2001)

shape and level of the relationship. Figure 1 indicates that B is negative, i.e., a given increase in enforcement from its current level leads to a lower level of crashes. The magnitude of B depends on the strength of the relationship between the specific type of enforcement and crashes. For the power function, B is often referred to as the "elasticity", i.e., the percentage change (reduction) in crashes for 1% increase in enforcement.

The following sections summarise research providing estimates of the relationships with crashes in the cases of speeding, drink-driving and drug-driving enforcement. From each study reviewed, an estimate has been made of the parameter B (elasticity) in a power function connecting the level of enforcement with risk of crashes or the injury severity of the crash outcomes. The statistical standard error of each estimate of elasticity was used in the subsequent meta-analysis of similar estimates as a weighting factor to provide a more reliable overall estimate.

Speed enforcement

Manual speed enforcement

The relationship shown in Figure 1 developed by Elvik (2001) was based on 11 studies of manual speed enforcement (involving police officers measuring speed and intercepting drivers) during 1966 to 1998. A later source indicated an elasticity of -0.04525 for this relationship (UK Department for Transport 2014).

Cameron and Delaney (2006) estimated a negative exponential relationship between casualty crash reductions and the annual offences detected by moving-mode radar units in Victoria, based on effects during 1995/96 and 1996/97 estimated by Diamantopoulou, Cameron and Shtifelman (1998); and Diamantopoulou and Cameron (2002). This data was revisited and a power function fitted, producing an estimated elasticity of -0.0581.

Mixed manual and camera-based speed enforcement

Povey, Frith and Keall (2003) estimated a logarithmic relationship between mean free speed and speeding tickets issued from mixed speed enforcement on New Zealand rural roads during 1996-2002. They also estimated a logarithmic relationship between "low alcohol hour" casualty crashes and mean speeds over the same years. These relationships were combined to produce a negative exponential relationship between relative crash risk and the increase in speeding tickets. A power function fitted to this relationship had an elasticity of -0.385.

Elvik (2011) extended the analysis of Elvik (2001) by adding four studies of speed camera effects related to camera hours or speeding tickets issued for detected offences. Effect estimates were related to the levels of increased speed enforcement (either manual or camera-based) from a base level in each case. Functional relationships between them were analysed, either weighting or not weighting each effect estimate by a measure of statistical reliability (reciprocal of the standard error squared). Elvik (2011) preferred the resulting logarithmic and inverse functions, respectively, but also provided results for fitted power functions. The estimated elasticities were -0.299 (weighted estimates) and -0.190 (unweighted).

Table 1: Estimated elasticities of manual and mixed speed enforcement levels

Manual and mixed (manual and camera) speed enforcement	Non- camera enforcement	Mixed with Elvik (2011) weighted	Mixed with Elvik (2011) un-weighted
Global estimate	**-0.0461**	**-0.2994**	**-0.1908**
Standard error	0.0019	0.0020	0.0020

Meta-analysis of manual and mixed speed enforcement

A meta-analysis of the elasticity estimates from the studies involving manual speed enforcement was conducted to provide global estimates of the elasticity for manual (only) enforcement and mixed (manual or camera-based) enforcement. The method followed the meta-analysis approach of Christensen (2003). The individual effect estimates are weighted by the reciprocal of their standard error squared and a weighted average calculated to provide the global estimate. This method is more appropriate than a simple arithmetic average because the weights reflect the reliability of each elasticity estimate. The standard error of the global estimate is also provided (Table 1). Further details of the meta-analyses summarised in this paper are given in Cameron, Diamantopoulou and Newstead (2015).

Covert mobile speed cameras

Since the covert operation of mobile speed cameras was first introduced in Victoria in December 1989, there have been a series of evaluations of their general effect on crashes as the program expanded during 1990 and 1991 and then later years. Each of these evaluations used models in which monthly crashes were expressed as multiplicative functions of mobile camera activity (camera hours or speeding tickets issued from camera detections) and other influential factors (random breath tests, Transport Accident Commission television publicity, economic conditions measured by unemployment rates, long-term trend and seasonal variation in crashes). In these multiplicative functions, the relationship between mobile camera activity and crashes was a power function and the elasticity was estimated as part of the analysis. This assumed that the coefficients were fixed effects over the period analysed.

The first evaluation analysed monthly casualty crashes during "low alcohol hours" (LAH) in Melbourne during 1983 to 1991 (Cameron et al 1992). A statistically significant elasticity of -0.0132 was found between monthly tickets issued from mobile camera detections and casualty crashes on arterial roads (where most camera operations took place). The analysis also found a significant elasticity of -0.0233 between mobile camera tickets and the severity

of casualty crashes, measured by the proportion of crashes with serious outcomes (resulting in a fatality or hospitalisation).

Subsequent studies focused on the elasticity with serious casualty crashes. Analysing LAH serious crashes during 1983 to 1992, Newstead et al (1995) found a significant elasticity of -0.0243 with mobile camera tickets in Melbourne and -0.0098 with mobile camera tickets in the rest of Victoria.

Similar analysis of serious casualty crashes in Melbourne during 1983 to 1996 found a significant elasticity of -0.0209 between mobile camera tickets and LAH crashes (Newstead et al 1998). The analysis also found a significant elasticity of -0.0109 with "high alcohol hour" (HAH) serious casualty crashes, but no significant elasticities were found between tickets and crashes outside Melbourne.

As part of a cost-benefit analysis of mobile speed cameras, Gelb et al (2000) analysed monthly LAH casualty crashes in Melbourne during 1987 to 1998. They found significant elasticities of -0.0179 with mobile camera hours and -0.0122 with mobile camera tickets.

During 1999, Victoria Police varied the levels of speed camera activity substantially in four Melbourne Police districts according to a systematic plan (Cameron et al 2003). Analysis of casualty crashes during 1996 to 2000 found they were inversely related to changes in the levels of speeding tickets issued following detection in the same district during the previous month. When a power function was fitted, the elasticity was estimated to be -0.1115 (Cameron and Delaney 2006). A similar relationship was found for the risk of fatal outcome in a casualty crash, with an estimated elasticity of -0.8516 in this case.

An evaluation of speed-related initiatives in Victoria during 2000-2002 (including 50% increased mobile speed camera hours and reduced offence tolerance) analysed monthly casualty crashes and their fatal outcomes from 1998 to 2003 (Bobevski et al 2007). The elasticity between mobile camera hours and casualty crashes was estimated to be -0.092, whereas the elasticity with the risk of fatal outcome in these crashes was estimated to be -2.03. Elasticities with camera tickets could not be estimated due to the reduced tolerance.

Meta-analysis of covert mobile speed cameras

A meta-analysis of the elasticity estimates from the evaluations of covert mobile speed cameras was conducted to provide global estimates and their standard errors (Table 2). The estimates relevant to studies of the effects on casualty crashes, serious casualty crashes, and the risk of fatal outcome in casualty crashes have been meta-analysed separately because the elasticities relate to fundamentally different risks.

Overt mobile speed cameras

The tripling of speeding tickets issued from detections by overtly-operated mobile speed cameras in Ireland between 1997 and 2000 was associated with a significant decrease in casualty crashes compared with all reported crashes (Smith et al 2001). The elasticity between annual tickets issued and the casualty crash rate was estimated to be -0.1428.

Table 2: Estimated elasticities of covert mobile speed camera levels

Covert mobile speed cameras in Victoria	Casualty crashes	Serious casualty crashes	Fatal outcome in casualty crashes
Global estimate	**-0.1054**	**-0.0225**	**-0.9838**
Standard error	0.0038	0.0034	0.1939

A series of evaluations of the crash effects of Queensland's mobile speed cameras was conducted as the program grew from 852 hours per month in 1997 to about 6,000 hours per month during 2003-2006 (Newstead and Cameron, 2003; Newstead, 2004, 2005, 2006). Crash reductions were generally limited to an area within 2 km of the camera sites. The strongest effects were on casualty crashes, with no differential effect on crashes of different severity (fatal, hospital admission, or medical treatment crashes). The elasticity between monthly camera hours and casualty crashes within 2 km was estimated to be -0.2416.

A characteristic of the Queensland program is the randomised scheduling of camera sessions to sites, thus contributing to their unpredictability across the broader road system. As the program grew, the 2 km areas around camera sites covered a greater proportion of the total casualty crashes in Queensland, rising from about 50% to 83% over the evaluation period. The localised crash reductions around camera sites can be interpreted as a general effect on crashes, even assuming that the program had no effect beyond the 2 km areas. A logarithmic relationship between the increased monthly hours and the general casualty crash reductions in Queensland was calibrated by Cameron (2008). A power function explains this relationship equally as well, with an estimated elasticity of -0.2202. The relationship between fatal crashes and camera hours was also estimated. There was no evidence that the magnitude of the reduction on fatal crashes was any greater than that achieved on casualty crashes.

Newstead et al (2014) updated the evaluations of the Queensland program, estimating crash effects each year from 1997 to 2011 (all casualty crashes) and to 2012 (serious casualty crashes). During 2010 to 2012, the percentage of mobile camera hours operated covertly rose from 7.2% to 23% and then fell to 20%. In contrast with earlier research, crash effects were estimated within 1 km of urban camera sites and within 4 km of rural sites. These areas covered about 78% of total casualty crashes in Queensland during the latter years.

The elasticity between monthly camera hours and casualty crashes within 1 or 4 km of camera sites was estimated after taking into account the separate effects of the reduced enforcement tolerance in 2008 (11% crash reduction) and partial covert operations from 2010 (not statistically significant). The estimated elasticity between hours and the local casualty crash risk was -0.0794. When the local crash

Table 3: Estimated elasticities of overt mobile speed camera levels

Overt mobile speed cameras in Queensland (& Ireland)	Casualty crashes (general effect)	Serious casualty crashes (general effect)	Local effect on casualty crashes
Global estimate	**-0.1277**	**-0.0345**	**-0.0982**
Standard error	0.0104	0.0132	0.0121

effect was interpreted as a general casualty crash effect across Queensland, the estimated elasticity with camera hours was -0.0618.

Elasticities between camera hours and serious casualty crashes were also estimated, including 2012 data and again taking into account the reduced enforcement tolerance (13% crash reduction) and partial covert operations (not statistically significant). The estimated elasticity between hours and the local serious casualty crash risk was -0.0469. When interpreted as a general effect on serious casualty crashes, the estimated elasticity with hours was -0.0345. As found in previous research, there appeared to be no greater effect of the Queensland mobile cameras on the more severe crashes than on casualty crashes in general.

Meta-analysis of overt mobile speed cameras

A meta-analysis of the elasticity estimates from the evaluations of overt mobile speed cameras was conducted to provide global estimates and their standard errors (Table 3). The estimates relevant to studies of the effects on all casualty crashes and serious casualty crashes (general effects), and local effects on casualty crashes (within a few kilometres of camera sites), have been meta-analysed separately because the elasticities relate to different effects.

Random breath testing

Since the introduction in 1990 of high-profile bus stations ("booze buses") that substantially increased the number of random breath tests in Victoria, a series of studies have estimated the relationship between the monthly number of tests and crash reductions. Each of these studies used models in which monthly HAH crashes were expressed as multiplicative functions of the number of tests and other influential factors (speed camera tickets, TAC television publicity, economic conditions measured by unemployment rates, and trend and seasonality).

In an evaluation of alcohol-related Transport Accident Commission publicity, Cameron et al (1993) modelled monthly HAH serious casualty crashes in Melbourne during 1983 to 1992 and found an elasticity of -0.0176 with the monthly tests (from either car- or bus-based testing stations). They also modelled the non-serious casualty crashes in Melbourne and found an elasticity of -0.0167. These findings led to models of all casualty crashes during HAH, in which elasticities between monthly random breath tests and crashes were estimated as -0.0115 in Melbourne and -0.0118 in the rest of Victoria.

Newstead et al (1995) also modelled monthly HAH serious casualty crashes in Melbourne during 1983 to 1993 and estimated an elasticity of -0.0186 between crashes and tests. Further modelling of these crashes during 1983 to 1996 (Newstead et al 1998) estimated elasticities of -0.0204 in Melbourne and -0.0155 in the rest of Victoria.

In modelling monthly casualty crashes in (then) five Police Regions in Victoria during 1989 to 1997, Diamantopoulou et al (2000) used a structural time series analysis method which potentially provided more reliable estimates of the coefficients of the multiplicative models. Estimated elasticities between monthly random breath tests (from either car- or bus-based testing stations) and HAH casualty crashes ranged from -0.1496 to -0.1013. Statistically significant elasticities between tests and LAH casualty crashes were also found, ranging from -0.1910 to -0.0958.

Henstridge et al (1997) examined the association between daily levels of random breath tests and serious casualty crashes in New South Wales. Crashes during the period 1976 to 1992 were analysed, including the high-profile introduction of RBT in December 1982 that needed to be modelled as a specific short-term effect. The analysis confirmed that diminishing returns-type relationships apply to levels of RBT. A 10% increase in the current testing levels (6,300 per day) was associated with a 3.5% reduction in serious casualty crashes, suggesting an elasticity of -0.35.

In Western Australia from the year 2000 to 2011, the number of roadside preliminary breath tests (90% random) per licensed driver was reduced by 49%. The percentage of killed drivers found to have BAC greater than 0.05g/100ml increased substantially during the period. Analysing the annual tests and annual percentage of killed drivers, Cameron (2013a) estimated an elasticity of -0.236 between them. However, change in the percentage of drivers killed with illegal BAC gives an exaggerated view of the change in the relative risk of a driver being killed. When this was taken into account, an elasticity of -0.115 was estimated between the annual preliminary breath tests per licensed driver and the relative risk of driver fatalities.

Meta-analysis of random breath testing

A meta-analysis of the elasticity estimates from the evaluations of random breath testing was conducted to provide global estimates and their standard errors (Table 4). The estimates relevant to studies of the effects on casualty crashes, serious casualty crashes, and killed drivers have been meta-analysed separately because the elasticities relate to different effects.

Roadside drug testing

Roadside oral fluid tests (ROFTs) of drivers for three proscribed drugs were introduced in Victoria in December 2004. Not all tests were conducted on a random selection of drivers, but up to 2009 most of the tests were considered to be "random drug tests" (RDT) aimed at general deterrence of drug driving. The number of drivers screened by ROFTs in Victoria increased each year from 13,158 in 2005 to 27,883 in 2009. The detection rate of proscribed drugs fell

Table 4: Estimated elasticities of random breath testing

Random breath testing in Victoria, NSW and Western Australia	Casualty crashes	Serious casualty crashes	Killed drivers relative risk
Global estimate	**-0.0132**	**-0.0184**	**-0.115**
Standard error	0.0027	0.0024	0.096

from 2.3% to 1.0% during the same years (Boorman 2010). The percentage of killed drivers found to have an impairing drug in their blood fell during the same period.

The relationship between the annual number of ROFTs and the annual percentage of killed drivers with at least one of the proscribed drugs is shown in Figure 2. An even stronger relationship is apparent between the number of ROFTs and the percentage of killed drivers with any impairing drug (including the three proscribed drugs).

The estimated elasticity between the annual ROFTs and the percentage of killed drivers with a drug present was found to be -0.260 in the case of any impairing drug, or -0.288 in the case of one or more proscribed drugs (Cameron 2013b). However, change in the percentage of drivers killed with drugs present gives an exaggerated view of the change in the relative risk of a driver being killed. When this was taken into account, it was estimated that the elasticity between annual ROFTs and the relative risk of driver fatalities was between -0.145 (based on the deterrence of combining any impairing drug with driving) and -0.069 (based on the deterrence of proscribed drug driving). A global estimate of this elasticity is given in Table 5.

Fixed camera systems

The intensity of fixed operations, usually camera-based, is principally measured by the number of sites covered (within an enforcement halo). The effect of fixed camera-based operations on road trauma is related to the number of sites and the road trauma reduction at each individual site. The following sections summarise research that has evaluated the effect of each type of fixed camera system on crashes at various levels of injury severity.

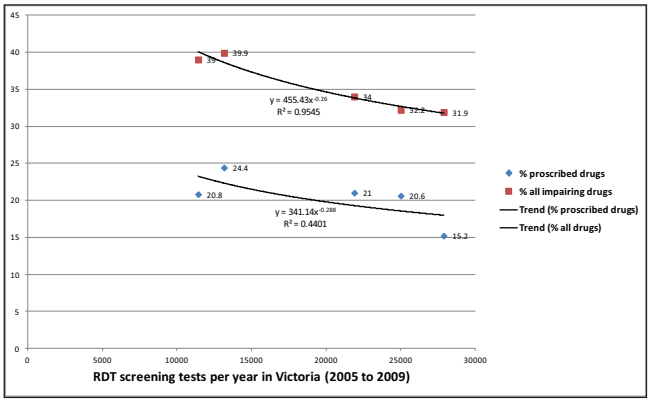

Figure 2: Relationships between percentage of killed drivers with proscribed drugs, or any impairing drug, versus number of drivers screened by ROFTs in Victoria

Fixed spot-speed cameras

The most comprehensive experience with fixed spot-speed cameras comes from the UK, where the program has also been carefully evaluated at each stage during its expansion. Results at each stage of the expansion indicate that the fixed cameras have achieved 5% to 42% reductions in casualty crashes and 47% to 65% reductions in serious casualties (fatalities and serious injuries) at camera sites (Cameron and Delaney 2006). Similar experience has been seen with the initial 28 overt fixed speed cameras in New South Wales. At camera sites, casualty crashes were reduced by 23% and fatal crashes by 90% (ARRB 2005).

The UK speed camera program had expanded to 4,000 sites by the time of the most recent evaluation study (Gains et al 2005). The estimated benefit-cost ratio of 2.7 during its fourth year was typical or marginally lower than what had been achieved in earlier years (BCRs of 2.75 to 3.4). The benefit-cost ratio of the first 28 overt fixed speed cameras in New South Wales was also no more than 3.6. These findings suggest that the overall effects of fixed speed cameras is essentially the sum of their individual localised effects, and that the program benefit-cost ratio is essentially the same as individual fixed camera installations.

In this study, it was envisaged that fixed spot-speed cameras in Victoria would continue to be placed on urban and rural

Table 5: Estimated elasticities of roadside drug testing

Roadside drug testing in Victoria	Period	Estimated elasticity (Power B)	Stand-ard error	Killed drivers relative risk	Elasticity based on relationship between annual ROFTs and killed drivers:
Cameron (2013b)	2005-2009	-0.260	0.0328		% with impairing drug
	2005-2009	-0.288	0.1872		% with proscribed drug
	2005-2009	-0.145	0.0193	1*	deterrence of impairing drugs
	2005-2009	-0.069	0.0441	1	deterrence of proscribed drugs
Global estimate				-0.1328	
Standard error				0.0177	

*** The index (1) indicates the specific elasticity estimate contributing to the global estimate.**

freeways, following current practice. It was estimated that fixed speed cameras inhibit speeding for up to about 5 km from the camera site (ICF 2003).

The average reduction in casualty crashes at fixed camera sites across all studies was 26.2%, whereas the average reduction in serious casualty crashes was 53.3%, about twice the magnitude. In the UK studies, the crash reductions had been measured over one kilometre road lengths centred on the fixed camera site. The evaluation of fixed speed cameras in NSW also considered road sections adjacent to and upstream and downstream from the camera site section (each about 1-2 kilometres), so that effect on crashes on the total section of about 5 km could be assessed. Over the combined 5 km lengths there was only 7.76% reduction in casualty crashes (ARRB 2005). Because of the known greater effect of fixed cameras on more serious injury crashes, it was assumed in the analysis here that serious casualty crashes would be reduced by twice this amount, i.e. 15.52%.

Point-to-point average-speed camera systems

A comprehensive review of P2P systems internationally has been carried out by Soole et al (2012, 2013), including a summary of estimated effects on crashes at various injury severity levels. Many of the early applications of P2P were on short road sections and mainly at roadwork sites. Table 6 extracts the crash reductions measured for P2P systems covering relatively long road sections (usually involving multiple links each at least 2 km in length). The measured reductions for fatal, serious injury or minor injury crashes specifically have been averaged in the last row of Table 6. Crash reductions of this magnitude were assumed if a point-to-point camera system was installed on each of the freeway links in Victoria.

Speed/red-light cameras

The assumed effect of each speed/red-light (SRL) camera on casualty crashes was the 26% reduction found in a study of installations at 77 signalised intersections (Budd, Scully and Newstead 2011). The same reduction was used for crashes of each injury severity because the study found no statistically significant evidence of differential crash reduction effects. This is apparently the most comprehensive evaluation of SRLs internationally.

Costs of traffic enforcement

As well as estimating the reductions in road trauma from increases in the intensity of each type of traffic enforcement in Victoria, it was necessary to compare this with the cost of each increase. To do this, it was necessary to estimate the costs per unit of intensity of each traffic enforcement type, covering equipment capital cost and maintenance, person operating costs, and costs of offence processing. The process relied on information obtained from many sources, including other States, internationally, and non-government sources. In each case, the estimated unit costs have been updated to year 2014 prices using the CPI (and after conversion to Australian dollars, where necessary). Details are given in Cameron et al (2015).

Economies of scale are expected to be associated with each of the unit costs of offence detection. Except for random breath testing, this effect could not be represented in the unit costs. From information obtained in Western Australia (Cameron 2012), it was possible to estimate the cost per test (including officer time cost) as a function of the total number of RBT tests per year. In contrast, the unit cost of a random drug test (RDT) was considered fixed and included the preliminary oral fluid test (POFT) device and, where applicable (estimated 3.2% of POFTs), the secondary OFT and laboratory test cost.

The unit cost of each fixed camera system was estimated differently. Because each of these systems operates continuously, the cost per hour is small. The purchase price was amortised over the useful life, discounted at 7% per annum, and then added to the annual maintenance cost to provide an estimate of the total annual cost of each fixed camera system in Victoria.

No information was available on the unit cost of processing a drink- or drug-driving offence detected by random breath or drug testing operations. These unit costs could be substantial, involving officer time to prepare a brief and attend court, if the offence is so severe that it is not eligible to be processed by a traffic infringement notice.

Options for traffic enforcement in Victoria

Crashes in Victoria during 2012 to 2014 were classified by the different road environments that were considered to represent the principal targets for the application of each type of traffic enforcement. For each targeted road environment, one or more enforcement types that could be applied were defined (Table 7).

Table 6: Estimated reductions in fatal, serious injury and minor injury crashes due to major P2P systems (Soole et al 2012, 2013). Average crash reduction across enforced sections.

Jurisdiction	Location	Highway	Length (km)	Fatal crashes	Serious injury crashes	Minor injury crashes
England	Cambridgeshire	A14	22.4	65.4%*		20.2%
Scotland	Strathclyde	A77	51.5	50.0%	40.6%	19.3%
Italy	All	ASPI motorways	2900	50.8%	34.8%	
Austria	Vienna	A22 tunnel	2.3	48.8%*		32.2%
Average				50.4%	37.7%	23.9%

*** Available information covered reduction in fatal and serious injury crashes combined. Not included in average.**

Table 7: Enforcement types considered in each road environment

TARGET ROAD ENVIRONMENT	Enforcement type
RURAL VICTORIA	
Freeway (518 km* 2 directions)	Fixed spot-speed camera (uni-directional)
	P2P camera system (uni-directional, covering up to 3 lanes)
Divided Highway (418 km)	Semi-covert Mobile Speed Camera (MSC) (unmarked/unsigned)
	Overt Mobile Speed Camera (with random scheduling)
Undivided Roads (134,030 km)	Semi-covert Mobile Speed Camera (MSC) (unmarked/unsigned)
	Overt Mobile Speed Camera (with random scheduling)
	Moving Mode Radar (MMR)
Town Street	Hand Held laser/radar
	Bus-based Random Breath Test (RBT)
	Bus-based Random Drug Test (RDT)
All rural road environments	Car- & Bus-based RBT
	Car-based Preliminary Breath Test (PBT) (not random)
	Car- & Bus-based RDT
	Car-based Roadside Oral Fluid Test (ROFT) (targeted)
URBAN (Melbourne)	
Freeway (273 km* 2 directions)	Fixed spot-speed camera (uni-directional)
Arterial Road (2,927 km)	Covert Mobile Speed Camera (MSC)
Signalised Intersection (2,908)	Speed/Red-Light camera (SRL)
Street (21,300 km)	Hand Held laser/radar
All urban road environments	Bus-based RBT
	Car-based RBT
	Car-based PBT (not random)
	Car- & Bus-based RDT
	Car-based ROFT (targeted)

In part, this assignment to each road environment reflected uncertainty about the likely general effect of the enforcement type, or whether only a local effect in the vicinity of operation is assumed. RBT was considered to have a potential general effect across rural and urban Victoria. However, rural RBT carried out at bus-based testing stations may have only a general effect across the rural towns in which they operate. (Similarly, in Melbourne, bus-based RBT may have only a local effect on the arterial roads to which buses are constrained in general).

Rural bus-based random drug testing (RDT), because it is generally carried out in conjunction with RBT at buses, was considered in the same way.

Current levels of traffic enforcement in Victoria

Victoria Police provided information on the hours of operation, numbers of roadside tests, and/or numbers of prosecutions for each enforcement type during a recent year (Table 8). Hours and traffic infringement notices (TINs) from mobile speed cameras were not separately available for each type of rural road. The totals were split in proportion to total vehicle-kilometres on divided and undivided highways (25%: 75%).

Covert mobile speed cameras are operated from unmarked cars at unsigned locations on rural highways, but are not considered to be as covert as operations on urban arterial roads. For this reason, they were labelled as "semi-covert" on rural roads. Overt mobile speed cameras (with random scheduling to sites, as operated in Queensland) are not currently operated in Victoria. It was assumed for analysis that overt mobile speed cameras could be an alternative to the "semi-covert" mobile cameras on rural highways, and hence their base level of hours operated would be the same as the current level of the semi-covert cameras.

Bus-based random tests for alcohol (RBT) and drugs (RDT) in rural Victoria were considered to have occurred mainly in towns and the analysis initially used the bus-based tests as the base in that road environment. There are plans to expand the rural RDT operations to include random ROFTs from highway patrol cars to cover rural roads more broadly.

In Table 8, numbers of prosecutions resulting from alcohol and drug testing operations were not available and ultimately their costs of offence processing were ignored.

Effects of increased enforcement of each type

Elasticities and crash reductions

The appropriate elasticities in Tables 1-5 were extracted for each type of enforcement with variable levels of operation. The estimated crash reductions associated with each type of fixed camera system, outlined in Section 2.5, were also extracted (Cameron et al 2015).

The operation of "semi-covert" mobile speed cameras on rural roads was not considered to be as effective as covert operation on urban arterial roads. For these operations, the elasticity associated with fatal outcome risk of casualty crashes (Table 2) was halved.

The estimated elasticity between RDT and driver fatalities was similar to that found for RBT (Table 4 and 5). For this reason it was considered that RDT would have elasticities with lower severity crashes similar to that found for RBT. In particular, it was estimated that the elasticity between RDT and serious casualty crashes is the same as that for RBT (Table 4).

Table 8: Annual levels of traffic enforcement in Victoria during 2012/13 or 2013, where available. Estimates italicised (explanation in text).

		BASE YEAR LEVELS			
TARGET ROAD ENVIRONMENT	Enforcement type	Units - devices or P2P sections	Hours (if variable)	Assessments (tests)	Prosecutions (TINs)
RURAL VICTORIA					
Freeway	Fixed speed camera	8			81,860
	P2P camera system	8			44,307
Divided Highway	Semi-covert MSC		*11,930*		*25,277*
	Overt MSC		*11,930*		*25,277*
Undivided Road	Semi-covert MSC		*35,789*		*75,830*
	Overt MSC		*35,789*		*75,830*
	MMR		71,631		86,543
Town Streets	HH laser/radar	Included in urban street operations below			
	Bus RBT			*54,563*	NK
	Bus RDT			*2,352*	NK
All rural roads	Car & Bus RBT			*575,061*	NK
	Car PBT (not random)			*319,433*	NK
	Car ROFT (targeted)			13,062	NK
URBAN (Melbourne)					
Freeway	Fixed speed camera	18			252,033
Arterial	Covert MSC		63,018		394,297
Signalised Intersection	SRL camera	175			405,466
Street	HH laser/radar	841	29,792		96,967
All urban roads	Bus RBT			*1,039,941*	NK
	Car RBT			*780,747*	NK
	Car PBT (not random)			*479,150*	NK
	Car & Bus RDT			19,789	NK
	Car ROFT (targeted)			4,081	NK
ALL VICTORIA					
All Victorian roads	All Alcohol Screening Tests			3,194,332	NK
	All RDT (bus & car)			22,141	NK

No elasticities were available for non-random car-based preliminary breath testing (PBT) for alcohol nor car-based roadside oral fluid testing (ROFT) of drugs in targeted operations. While these impaired driver tests have occurred in substantial numbers in Victoria, it has not yet been possible to link these tests with the deterrence of drink- and drug-driving. Further research is required to determine if relationships exist and to estimate their elasticities.

The elasticities for an increase in total alcohol screening tests (random and non-random) were assumed to be the same as for RBT (from Table 4). An increase in total roadside tests for alcohol was considered in order to include the effect of non-random car-based PBTs.

A 50% increase in enforcement levels

For the initial analysis, a 50% increase in each type of enforcement applied to the specific road environments shown in Tables 7 and 8 was considered. The 50% increase was applied to the number of enforcement units, hours of operation, or roadside tests per year. The number of prosecutions resulting from detected offences was similarly increased by 50% although it could be expected that offence rates and hence detections would not increase to the same extent. Adjustment for reduced offence rates was beyond scope of the analysis in this paper.

Each type of enforcement is expected to have a general effect on the crashes in the road environment on which it is focused. The magnitude of the crash reduction is related to the elasticity, in conjunction with the enforcement increase, or to the percentage crash reduction applied to the annual

Table 9: Crash focus of each fixed camera system and hand-held laser/radar device

Road environment	Enforcement type with limited focus in the road environment	Halo or coverage assumed	Total of road environ-ment	Crash ranking selection factor	Focus on total crashes in the road environment
Rural freeway	Fixed speed camera	5 km	2 x 518 km	4.53	2.19%
Rural freeway	P2P camera system	av. 10 km	2 x 518 km	2 (est.)	1.93%
Melbourne freeway	Fixed speed camera	5 km	2 x273 km	4.53	4.15%
Signalised intersection	SRL camera	All legs	2,908 int's	2.3	0.079%
Urban street	Hand-held laser/radar	2 km	20% of 21,300 km	2.72	0.128%

number of crashes. The exception to this general effect is in the case of those enforcement types that have a limited halo or coverage across the road environment in which the enforcement operates, e.g. fixed camera systems.

Crash focus of traffic enforcement types with limited halo or coverage

The effects of the fixed camera systems and hand-held laser/radar speed detection devices were considered to be limited to crashes within the halo of influence or the length of road covered by the enforcement. There is no evidence of a general effect of the UK fixed speed cameras beyond the strong local effects identified. Point-to-point speed camera systems are assumed to affect crashes only on the road section. Speed/red-light intersection cameras appear to affect crashes on all road legs (26% casualty crash reduction), notwithstanding an even stronger effect on the approach road on which the camera is located (Budd et al 2011).

The proportion of the total size (e.g. length) of the road environment represented by the halo or coverage of the enforcement was considered to be the proportion of crashes

Table 10: Estimated percentage crash reductions from 50% increase in each enforcement type. Italicised estimates: see further explanation in text.

		CRASH REDUCTION (% of target crashes/severity)					
TARGET ROAD ENVIRONMENT	Enforcement type	Fatal crashes per casualty crash	Fatal crashes	Hospital admission crashes	Total serious casualty crashes	Medical treatment crashes	Total casualty crashes
RURAL VICTORIA							
Freeway	Fixed speed camera				-1.36%		-0.68%
	P2P camera system		-3.89%	-2.91%		-1.85%	
Divided Highway	Semi-covert MSC	*-18.1%*	*-21.5%*				*-4.18%*
	Overt MSC						-5.05%
Undivided Roads	Semi-covert MSC	*-18.1%*	*-21.5%*				*-4.18%*
	Overt MSC						-5.05%
	MMR						-1.85%
Town Streets	Bus RBT		-4.56%		-0.74%		-0.53%
	Bus RDT		-5.24%		*-0.74%*		
All rural roads	Car & Bus RBT		-4.56%		-0.74%		-0.53%
URBAN (Melbourne)							
Freeway	Fixed speed camera				-5.79%		-2.90%
Arterial	Covert MSC	-32.9%	-35.7%				-4.18%
Signalised Intersection	SRL camera						-1.80%
Street	HH laser/radar				-2.39%		-2.02%
All urban roads	Bus RBT		-4.56%		-0.74%		-0.53%
	Car RBT		-4.56%		-0.74%		-0.53%
	Car & Bus RDT		-5.24%		*-0.74%*		
ALL VICTORIA							
All Victorian roads	All AST (R & not R)		-4.56%		-0.74%		-0.53%
	All RDT (bus & car)		-5.24%		*-0.74%*		

Table 11: Estimated crashes saved by 50% increase in enforcement & total social benefit. Italicised estimates derived from bold estimates by addition and interpolation.

		CRASHES SAVED (p.a.)					BENEFIT
TARGET ROAD ENVIRONMENT	Enforcement type	Fatal crashes	Hospital admission crashes	Total serious casualty crashes	Medical treatment crashes	Total casualty crashes	Total value of crash saving per year ($m)
RURAL VICTORIA							
Freeway	Fixed speed camera	*0.16*	*1.02*	1.19	*0.08*	1.27	1.76
	P2P camera system	0.47	2.19	*2.66*	1.84	*4.50*	4.95
Divided Highway	Semi-covert MSC	1.00	2.32	3.32	*5.51*	8.83	9.90
	Overt MSC	*0.24*	*4.00*	*4.24*	*6.41*	10.65	4.19
Undivided Roads	Semi-covert MSC	31.04	*14.68*	*45.73*	*44.81*	90.53	270.99
	Overt MSC	*7.28*	*55.15*	*62.43*	*46.76*	109.20	87.05
	MMR	*2.67*	*20.24*	*22.91*	*17.16*	40.07	31.94
Town Streets	Bus RBT	1.03	*4.15*	5.18	*8.67*	13.85	11.18
	Bus RDT	1.19	*3.99*	5.18	NK	*5.18*	11.48
All rural roads	Car & Bus RBT	8.37	*6.18*	14.55	*12.98*	27.53	73.98
URBAN (Melbourne)							
Freeway	Fixed speed camera	*0.73*	*11.38*	12.11	*6.27*	18.38	11.14
Arterial	Covert MSC	38.91	57.41	96.32	*234.71*	331.03	374.04
Signalised Intersection	SRL camera	*0.48*	*18.91*	*19.39*	*52.23*	71.62	16.90
Street	HH laser/radar	*0.47*	*22.28*	22.75	*45.25*	68.00	17.33
All urban roads	Bus RBT	7.65	*25.89*	33.54	*51.31*	84.85	79.63
	Car RBT	7.65	*25.89*	33.54	*51.31*	84.85	79.63
	Car & Bus RDT	8.81	*24.73*	33.54	NK	*33.54*	83.22
ALL VICTORIA							
All Victorian roads	All AST (R & not R)	16.02	*32.06*	48.09	*64.29*	112.37	153.61
	All RDT (bus & car)	18.43	29.65	48.09	NK	*48.09*	165.87

that are its focus. To this must be added that all of the fixed camera systems are typically located in places that have been ranked with high numbers of serious crashes per unit length or per intersection. Experience in Queensland and Western Australia (Cameron 2008, 2009, 2010) has found that this crash ranking typically results in fixed camera systems being placed at locations with crash rates typically 2 to 4.5 times higher than the average crash rate in the road environment (Table 9). These considerations allowed the focus of each fixed camera system on the percentage of total crashes in the road environment to be estimated.

Benefits of 50% increase in enforcement

The estimated percentage reduction in crashes, or injury outcome at each severity level, due to the 50% increase in enforcement of each type is shown in Table 10. Apart from the fixed camera systems and hand-held laser/radar, the percentage reduction was estimated by applying a power function (e.g. Figure 1), with the appropriate elasticity, to the 50% increase in the base enforcement level shown in Table 8. In addition, for the covert and semi-covert mobile speed cameras (MSCs), the reduction in fatal crashes was estimated by combining the reduction in casualty crashes with the reduction in fatal crashes per casualty crash.

The percentage reductions due to the fixed camera systems and hand-held laser/radar devices were estimated by applying the increased number of systems/devices (50% increase) to the percentage of total crashes in the road environment considered to be the focus of each system/device (Table 9) and then to the estimated crash reduction within its halo or coverage (given in Section 2.5).

The percentage reductions shown in Table 10 were then used to estimate the annual crash savings for each type of enforcement considered in each road environment (Table 11).

The total social benefit of the savings in fatal, hospital admission and medical treatment crashes was estimated by weighting each crash saving by the "willingness to pay" (WTP) value of preventing each crash (PricewaterhouseCoopers 2008, Hensher et al 2009). Each fatal crash was valued at $8,391,870 in 2014. The hospital admission and non-admitted medical treatment crashes were valued at $376,734 and $110,115, respectively.

Table 12: Estimated costs of 50% increase in enforcement of each type

		COST OF INCREASED ENFORCEMENT ($m p.a.)			
TARGET ROAD ENVIRONMENT	Enforcement type	Capital cost of fixed cameras ($m amortised)	Offence detection	Offence processing	Total additional cost ($m p.a.)
RURAL VICTORIA					
Freeway	Fixed speed camera	0.100		0.761	0.861
	P2P camera system	0.606		0.412	1.018
Divided Highway	Semi-covert MSC		0.930	0.235	1.165
	Overt MSC		0.695	0.114	0.809
Undivided Roads	Semi-covert MSC		2.790	0.705	3.496
	Overt MSC		2.086	0.342	2.428
	MMR		2.000	0.928	2.928
Town Streets	Bus RBT		1.473	NK	1.473
	Bus RDT		0.177	NK	0.177
All rural roads	Car & Bus RBT		15.527	NK	15.527
URBAN (Melbourne)					
Freeway	Fixed speed camera	0.225		2.343	2.568
Arterial	Covert MSC		4.914	3.666	8.580
Signalised Intersection	SRL camera	1.714		3.770	5.484
Street	HH laser/radar		0.832	1.039	1.871
All urban roads	Bus RBT		9.939	NK	9.939
	Car RBT		9.172	NK	9.172
	Car & Bus RDT		1.486	NK	1.486
ALL VICTORIA					
All Victorian roads	All AST (R & not R)		18.665	NK	18.665
	All RDT (bus & car)		1.662	NK	1.662

Economic analysis of increased enforcement

Costs of increased enforcement

The annual cost of 50% increase in enforcement of each type was derived from the unit cost of equipment (amortised over its useful life), offence detection cost and offence processing cost (where known). The absence of information on the unit cost of processing drink- and drug-driving offenders meant these costs could not be included (Table 12). The only costs that reflect economies of scale are those estimated for the roadside alcohol testing (where more than 1 million tests p.a.), based on estimates made by WA Police (Cameron 2012).

Benefit-cost analysis of 50% increase in enforcement

The benefits of the increased enforcement, measured by the WTP value of the annual crash savings (Table 11), were compared with the additional costs in Table 13. The benefit-cost ratio (BCR) reflects the value of the increased savings compared with the increased cost, not the BCR of the total enforcement (150%). The marginal BCR is the benefit divided by cost of the next 1% increase in enforcement (to 51%). The BCR and marginal BCR of each fixed camera system are the same because no diminishing returns were assumed. The net present value (NPV) is the difference between the annual savings and the annual costs.

It is important to note that each of the estimated benefits are independent (applicable to an increase in the specific enforcement type alone) and are not necessarily additive. Some enforcement types are aimed at the same illegal behaviour in the same road environment. Even when the enforcement types differ in their target behaviour, it does not necessarily follow that their combined benefit is the sum of their individual effects. Methods to estimate the crash reductions from a combination of enforcement types are given by Elvik (2009) and have been applied as an illustrative example in the current context by Cameron et al (2015).

Benefit-costs of 100% to 300% increases in enforcement

Apart from the fixed camera systems, it could be expected that the analysis will reflect diminishing returns (crash savings) because the marginal crash reductions will decrease with increased enforcement and costs generally increase. The estimated BCR of 100% increase in enforcement of each type is generally lower than that of 50% increase (Table 14). The increase in the BCR for rural

Table 13: Benefit-cost ratio (BCR), marginal BCR, and Net Present Value (NPV) of 50% increase in enforcement of each type

		BENEFITS & COSTS OF INCREASED ENFORCEMENT ($m p.a.)				
TARGET ROAD ENVIRONMENT	Enforcement type	Total value of crash saving per year ($m)	Total additional cost of enforcement ($m)	**BCR:** Increase benefits/ increase costs	Marginal BCR(for next 1% increase in enforcement)	**NPV:** (Increase) benefits minus costs ($m)
RURAL VICTORIA						
Freeway	Fixed speed camera	1.76	0.861	**2.05**	2.05	**0.900**
	P2P camera system	4.95	1.018	**4.86**	4.86	**3.930**
Divided Highway	Semi-covert MSC	9.90	1.165	**8.50**	6.27	**8.737**
	Overt MSC	4.19	0.809	**5.18**	4.13	**3.380**
Undivided Roads	Semi-covert MSC	270.99	3.496	**77.52**	56.53	**267.490**
	Overt MSC	87.05	2.428	**35.85**	28.61	**84.617**
	MMR	31.94	2.928	**10.91**	8.85	**29.017**
Town Streets	Bus RBT	11.18	1.473	**7.59**	6.11	**9.711**
	Bus RDT	11.48	0.177	**64.99**	52.02	**11.300**
All rural roads	Car & Bus RBT	73.98	15.527	**4.76**	3.82	**58.449**
URBAN (Melbourne)						
Freeway	Fixed speed camera	11.14	2.568	**4.34**	4.34	**8.567**
Arterial	Covert MSC	374.04	8.580	**43.60**	29.41	**365.458**
Signalised Intersection	SRL camera	16.90	5.484	**3.08**	3.08	**11.419**
Street	HH laser/radar	17.33	1.871	**9.26**	9.26	**15.458**
All urban roads	Bus RBT	79.63	9.939	**8.01**	8.07	**69.692**
	Car RBT	79.63	9.172	**8.68**	9.97	**70.459**
	Car & Bus RDT	83.22	1.486	**56.01**	44.81	**81.738**
ALL VICTORIA						
All Victorian roads	All AST (R & not R)	153.61	18.665	**8.23**	7.52	**134.942**
	All RDT (bus & car)	165.87	1.662	**99.78**	79.75	**164.212**

car- and bus-based RBT with 100% increase compared with 50% is an artefact of the fixed cost per test ($54) used for total RBTs less than 1 million per year.

The influence of diminishing returns for further increases in those types of enforcement with variable levels of operation can be seen in Table 14. When the enforcement level is increased by 300%, the operation of either semi-covert or overt mobile speed cameras (MSC) on rural divided highways is approaching a break-even investment (marginal BCR less than 1.5).

The BCRs of each fixed camera system have not been included in Table 14 because they were considered fixed in the absence of assumptions about diminishing returns.

Summary of the economic analysis

It can be seen from Tables 13 and 14 that mobile speed cameras (operated covertly or semi-covertly) and random drug tests have the highest BCRs for a 50% increase and the highest marginal BCRs for further increases. In part this is due to these two enforcement types achieving relatively large reductions in fatal crashes. While many other methods of traffic enforcement have BCRs well above one, and should be included in a comprehensive road safety program, these two enforcement types currently represent the best return on investment in traffic enforcement in Victoria. At the other extreme, further investment in fixed types of camera-based enforcement appears to provide more modest returns, principally due to the limited halo effect or coverage of these enforcement methods.

Conclusion

A method has been developed to estimate the crash reduction benefits of increases in each type of traffic enforcement applied to an appropriate road environment in Victoria. This method has been based on numerous studies linking enforcement levels with road crashes and/or injury severity in the Australian States and internationally. Economic analysis of the crash savings and costs from investment in each type of traffic enforcement has shown that mobile speed cameras and random drug tests provide the highest benefit-cost ratios. The results may be different in other jurisdictions with different crash profiles and different base levels of each type of traffic enforcement.

Table 14: BCRs and marginal BCRs of 100% to 300% increases in enforcement types with varying levels of operation

		100% increase		200% increase		300% increase	
TARGET ROAD ENVIRONMENT	Enforcement type	**BCR**	Marginal BCR	**BCR**	Marginal BCR	**BCR**	Marginal BCR
RURAL VICTORIA							
Divided Highway	Semi-covert MSC	**6.78**	4.09	**4.90**	2.25	**3.88**	1.48
	Overt MSC	**4.34**	2.99	**3.36**	1.89	**2.77**	1.37
Undivided Roads	Semi-covert MSC	**61.44**	36.24	**43.95**	19.41	**34.49**	12.50
	Overt MSC	**30.09**	20.70	**23.25**	13.12	**19.21**	9.49
	MMR	**9.26**	6.56	**7.27**	4.30	**6.08**	3.18
Town Streets	Bus RBT	**6.41**	4.47	**4.99**	2.88	**4.14**	2.11
	Bus RDT	**54.66**	37.80	**42.36**	24.11	**35.08**	17.52
All rural roads	Car & Bus RBT	**9.07**	11.71	**9.32**	8.39	**8.91**	6.78
URBAN (Melbourne)							
Arterial	Covert MSC	**33.08**	17.19	**22.50**	8.27	**17.14**	5.02
All urban roads	Bus RBT	**7.88**	7.24	**7.31**	5.75	**6.79**	4.76
	Car RBT	**9.01**	8.97	**8.63**	7.11	**8.09**	5.87
	Car & Bus RDT	**47.10**	32.55	**36.48**	20.74	**30.20**	15.06
ALL VICTORIA							
All Victorian roads	All AST (R & not R)	**7.67**	6.44	**6.83**	5.02	**6.22**	4.13
	All RDT (bus & car)	**83.84**	57.84	**64.88**	36.77	**53.67**	26.66

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Contributed Articles

The Status of Global Road Safety: The Agenda for Sustainable Development encourages urgent action

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Introduction

Every year around 1.25 million people die as a result of a road traffic collision and between 20 and 50 million more sustain non-fatal injuries, some resulting in significant long term disabilities. These deaths and injuries, while devastating to victims and their families, also cost governments between 3-5% of their Gross Domestic Product (WHO, 2015).

More than a decade since the release of the WHO and World Bank *World report on road traffic injury prevention* in 2004 (WHO, 2004), there has been a major shift in understanding the issue. There is more recognition and increased road safety advocacy which has resulted in road traffic crashes now rightfully being considered a major health and development concern.

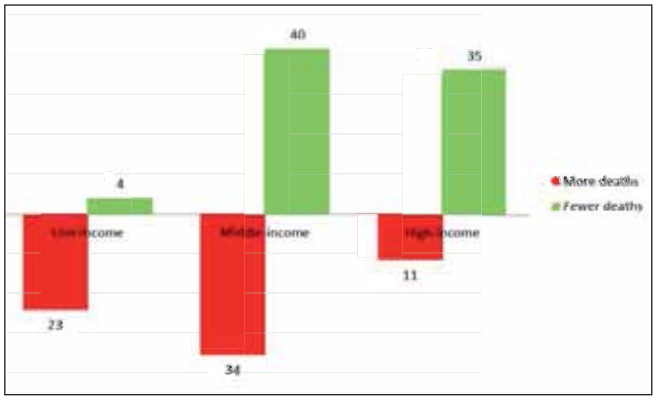


Figure 1: Countries showing changes in the number of road traffic deaths between 2010 and 2013 by income status*

***Note: only countries with more than a 2% change in their number of deaths between 2010 and 2013 were included in these calculations.**

Midway through the Decade of Action for Road Safety 2011-2020, the 2030 Agenda for Sustainable Development now includes road safety in two of its goals. This has the potential to give road safety, for the first time, the priority it deserves – a priority commensurate with the scale of this global challenge.

Midway through the Decade of Action

With recognition of road safety has come action, and a hint of good news. After more than a century of increasing road traffic deaths, WHO's *Global status report on road safety 2015* now shows a plateau in the number of road traffic deaths globally - this despite a 4% increase in the world's population and a 16% increase in the number of vehicles on the roads around the globe (WHO, 2015). Seventy-nine countries, mainly middle and high-income countries, have seen a decrease in the absolute number of deaths since 2010 while 68 countries, mainly in low- and middle-income countries, have seen an increase in deaths (see Figure 1).

Ninety percent of the 1.25 million road traffic deaths around the world are seen in low- and middle-income countries - despite these countries only having 54% of the world's vehicles (Table 1).

The African region continues to have the highest road traffic death rates (26.6 per 100 000 population versus a global rate of 17.4), while Europe appears to have the safest roads (9.3 per 100 000 population).

In the last three years, only 17 countries have aligned at least one of their laws with best practice on seat-belts, drink–driving, speed, motorcycle helmets or child restraints. While there has been progress towards improving road safety legislation and in making vehicles safer, the

Table 1: The status of road safety around the world by income level

	Global	Low-income	Middle-income	High-income
Estimated road traffic deaths	1.25 million	16%	74%	10%
Population	7.15 billion	12%	70%	18%
Estimated road traffic death rate per 100 000 population	17.4	24.1	18.4	9.2
Registered vehicles	1.8 billion	1%	53%	46%

report shows that the pace of change is too slow to attain the recommendation by UN General Assembly resolution 64/255 (UN, 2010) to increase the proportion of countries with good road safety laws up to 50%. At this time only laws on seat-belts meets this recommendation and much more needs to be done on the other key risk factors (Figure 2).

Despite some progress, the Status Report highlights the need to address the issue in a holistic "Safe Systems" approach thereby focusing not only on user behaviour, but also on the other components of the system; namely safe infrastructure and safe vehicles. Since more than half of all deaths occur among those outside a vehicle – 22% pedestrians, 4% cyclists and 23% motorcyclists - more focus needs to be placed on rethinking in particular urban settings to better protect these "vulnerable road users" if significant gains are to be made in countries. Furthermore, vehicles need to be made safer – vehicles sold in 80% of countries fail to meet seven key UN vehicle safety regulations (WHO, 2015).

Increasing action in the last five years of the Decade of Action

In September 2015, another milestone was achieved. Building on the efforts of WHO and many partners, road safety was included in two of the Sustainable Development Goals (SDG) – the Health Goal (3) and the Sustainable Cities and Communities Goal (11). Target 3.6 – to halve the number of global deaths and injuries from road traffic crashes – is very ambitious and is one of only a handful of targets with a 2020 end date. This means that in five years, many hundreds of thousands of deaths need to be averted in order to reduce the annual rate down to approximately 600 000 deaths per year. This will require substantially increased and concerted effort from multisectoral agencies within governments, international agencies, civil society and the private sector. In this context WHO is working with international partners to develop a package of core interventions which will assist Member States to put in place both effective and cost-efficient strategies to more rapidly address the problem.

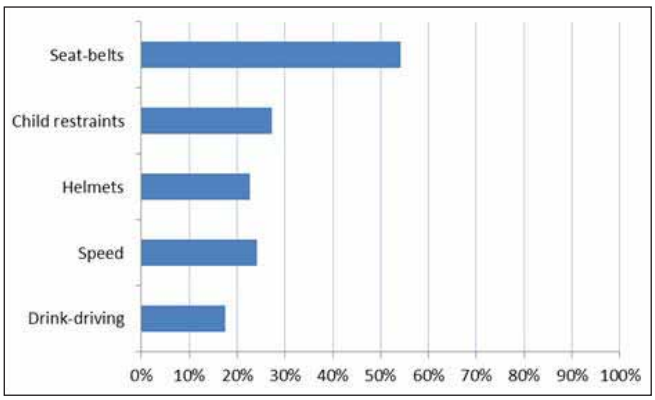


Figure 2: Proportion of countries with good laws* by risk factor

*** As defined in the** *Global status report on road safety 2015***.**

The 2nd Global High-Level Conference on Road Safety, hosted by the Government of Brazil and co-sponsored by WHO in November 2015, served as an opportunity to engage with policy-makers at the highest level to chart ways to fulfil the ambitious target set by the SDGs. Fifty-two ministers/vice ministers were among the 2000 strong delegates who adopted the Brasilia Declaration which calls on all countries to step up road safety activities (Brasília Declaration, 2015). A United Nations General Assembly resolution and a World Health Assembly resolution are likely to endorse the recommendations of this declaration in 2016.

While these political processes help to drive action, the true test of their power rests with their ability to affect change in countries, states/provinces, and municipal governments. This manifests through improved management of road safety, the adoption and enforcement of legislation around speeding, drinking and driving and the use of motorcycle helmets, seat-belts and child restraints; improvements in the safety of roads and vehicles; and enhancements in trauma care.

During the last six years WHO, in collaboration with partners, has been able to help achieve and demonstrate substantial gains in countries. These include reductions in speeding and increases in seat-belt and child restraint wearing in the Russian Federation (see Box 1) and Turkey; and reductions in drinking and driving and increases in motorcycle helmet wearing in Cambodia and Viet Nam, among others. Bloomberg Philanthropies was a key financial supporter of these initiatives and as a result of the success of the first grant announced a new five-year commitment (2015-2019) of US$ 125 million to global road safety focusing on five countries and 10 cities.

Conclusion

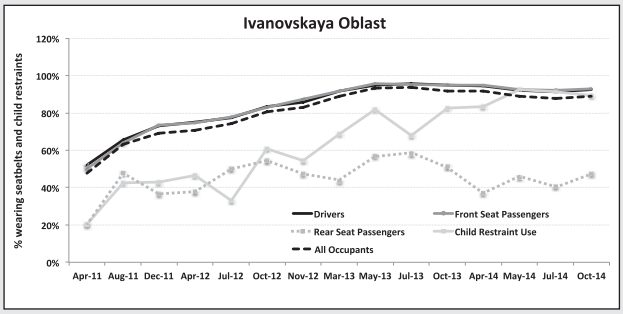
The Global status report on road safety 2015, reflecting information from 180 countries, indicates that worldwide the total number of road traffic deaths has plateaued at 1.25 million per year, with the highest road traffic fatality rates in low-income countries.

Box 1: Improving seat-belt and child restraint wearing in the Russian Federation

In the Russian Federation, the RS10 project was implemented from 2010 to 2014 by three partners – the World Health Organization, the Global Road Safety Partnership and Johns Hopkins University (JHU) – in cooperation with the Ministries of Health and Internal Affairs of the Russian Federation, in Lipetsk and Ivanovo regions, with the support of the Regional Administrations, the State Inspectorate for Road Safety and regional Departments of Health.

The goal of the project was to enhance road safety in the pilot regions through targeted actions addressing three risk factors – speeding, not wearing seat-belts and not using child restraints – with the potential for dissemination of the project experience in the Russian Federation in the medium term.

According to roadside surveys conducted by JHU together with Lipetsk State Technical University and Ivanovo State Polytechnic University, seat-belt use among all car occupants increased from 52.4% in October 2010 to 77.4% in October 2014 in the Lipetsk Region, and from 47.5% in April 2011 to 88.7% in October 2014 in the Ivanovo Region (see Figure).



Observed seat-belt and child-restraint use in Ivanovo Region, 2011−2014

Source: EURO, 2015

Under the banner of the Decade of Action for Road Safety 2011–2020, WHO will continue to focus on providing technical support to Member States to implement and monitor good road safety practices while continuing to act as the coordinator of road safety within the United Nations system together with the United Nations regional commissions. The passing of both United Nations and World Health Assembly resolutions during 2016 will provide further guidance to Member States and raise the profile of road traffic deaths and injuries higher on the global political agenda.

Urgent action is needed to achieve the target for road safety reflected in the newly adopted 2030 Agenda for Sustainable Development: halving the global number of deaths and injuries from road traffic crashes by 2020. Evidence from many high-income and a few middle-income countries show that while this might be technically possible, the momentum garnered in Brasilia at the Second Global High Level Conference on Road Safety needs to be converted into action in all countries around the world.

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Assembling the case and the coalition to achieve road safety's SDG health target

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In January 2016 the new Sustainable Development Goals (SDGs) or 'Global Goals' came into force. (Details on the Sustainable Development Goals are available at https://sustainabledevelopment.un.org). Together with the 'Paris Agreement' on Climate Change agreed in December 2015 (UNFCCC, 2015), the Global Goals define the international social, development, health and environmental agenda to 2030. The decision by negotiators from 190 countries, endorsed by world leaders, to include an ambitious and accelerated road safety target – set for 2020 – in the Global Goals demonstrates a recognition of the scale of this appalling human epidemic and the need for urgent action to reduce the toll of death, injury, misery and economic waste road crashes leave in their wake.

As with all SDG targets, the means of implementation and financing will be key to effective delivery, and moving from words on a communique to measurable action on the ground. For the road safety sector there are three key challenges:

- To secure sufficient international catalytic financing to assist governments of middle- and low-income countries to take the initial steps – building the institutional capacity, political will and evidence base - necessary to unlock sustainable sources of domestic funding to deliver long-term road safety strategies;
- To persuade finance ministers and private investors of the strong case for investment in safe and sustainable transport modes; that this isn't an optional extra, but should be mainstreamed into every transportation and land-planning decision;
- To integrate road safety and sustainable transport into the new financing mechanisms intended to support delivery of the Sustainable Development Goals and the climate change agenda.

Road safety is primarily an area of national competency, and ultimately has to be delivered by national, state/province, and local government. In the countries where road traffic injuries are on a sustained downward path this has been achieved by long-term political commitment, delivered through funded strategies driven by lead agencies or government departments with clearly delineated responsibilities and accountabilities for road safety working cooperatively on infrastructure; vehicle standards

and maintenance; driver training and licensing; public awareness and police enforcement; and through wider public health strategies (OECD and International Transport Forum, 2008). Funding is typically provided through a combination of general taxation, road user charges and taxes, insurance levies, penalty charges (for example from speed cameras) and through public/private finance initiatives.

However, in the context of developing countries with limited road safety capacity, there is a vital need for international catalytic financing to support the development of national road safety capacity reviews; political and technical institutional development; initial steps towards effective data management; strategy development; and demonstration projects; that can translate proven interventions to local circumstances. Taking these steps can create an enabling environment in which sustainable political support for long-term action to improve road safety, with the revenue streams to back it, becomes possible.

Financing for catalytic action

In 2006 the Commission for Global Road Safety, building on the recommendations of the WHO/World Bank World Report on Road Traffic Injury Prevention, estimated that around US$30 million of annual funding was the minimum required to effectively resource a strategic catalytic action plan (Commission for Global Road Safety, 2006). For a decade, the Commission, led by Lord Robertson of Port Ellen (now Chairman of the FIA Foundation), advocated for a higher profile for road safety within the UN system; for closer cooperation between the multilateral development banks and greater effort to ensure road safety is integral to all MDB-funded road infrastructure projects; and for inclusion of road traffic injury prevention within the international sustainable development agenda. It achieved a large measure of success in seeing each of these recommendations implemented. But in the major area of international catalytic financing, particularly, much remains to do.

Currently the only multi-donor global fund working to deliver the kind of strategic catalytic investment recommended by the Commission for Global Road Safety is the Global Road Safety Facility, launched in 2006 and hosted at the World Bank. The Facility, initially established with funding from the World Bank, the FIA Foundation, the Governments of Sweden and the Netherlands, and latterly from Australia, the UK and Bloomberg Philanthropies, deploys c. US$3 million a year (in addition to the Bloomberg funded work of GRSF in 10 cities and 5 countries) and has a strong focus on 'Safe System' delivery (Bliss & Breen, 2009). Funding is principally used to support capacity building, provide technical assistance and improve road infrastructure safety. In the first six years of operation funding was channeled to more than 30 countries, often integrated into Bank projects, and the Facility estimates that this catalytic support leveraged over US$500 million specifically committed to road safety investments (World Bank, 2013).

The other main sources of globally coordinated funding for road safety, supporting international, regional and national capacity building include philanthropic public health donors led by Bloomberg Philanthropies, and also including the FIA Foundation and the MAPFRE Foundation (see www.bloomberg.org, www.fiafoundation.org and www.fundacionmapfre.org for detail on these sources). Overall funding from these philanthropies is estimated to exceed US$20 million a year and finances a range of interventions, including national advocacy focused on legislative change; safety testing initiatives like the International Road Assessment Programme (iRAP) and the Global New Car Assessment Programme (Global NCAP), designed to generate demand for technical improvements and to advise on solutions; and pump-priming to support international road safety processes (www.irap.net and www.globalncap.org).

Private sector-supported initiatives currently include the Global Road Safety Initiative, a consortium of several private sector companies hosted by the Global Road Safety Partnership (GRSP), providing c. US$1 million a year for demonstration projects and technical assistance (www.roadsafetyfund.org). GRSP also manages an advocacy grant programme on behalf of Bloomberg Philanthropies and the Road Safety Fund, a collaboration between the FIA Foundation and the World Health Organization, raising c.US$1 million a year from private sector donations to support demonstration projects and advocacy by NGOs in developing countries (www.grsproadsafety.org). It is difficult to estimate the aggregated value of other road safety investments by donors within countries. Many OECD DAC governments provide support for road safety, either as part of broader development aid programmes or through discretionary grants by embassies. Some major corporate donors, for example FedEx, Johnson & Johnson and UPS Foundation, contribute significant grants supporting NGO activities. Most major car manufacturers have corporate social responsibility programmes and/or foundations working in their major market territories, although these typically focus on driver training and related areas, or child road safety education, rather than on capacity building.

It is generally accepted within the international road safety community that catalytic financing is needed if developing countries are to make real progress (WHO, 2011). The FIA Foundation's perspective as a donor is that there is significant un-met demand from LMIC governments and NGOs, and that some of the international agencies tasked with leading the fight against road traffic injuries – particularly the World Health Organization, but also the UN Economic Commission for Europe and other UN regional commissions – are also under-funded and generally under-resourced to work on road safety. Generating additional international funding for road safety should be a priority.

Securing health funding for a health target

With the inclusion of a road safety target within the Health Goal of the new SDGs we should see an accompanying paradigm shift in thinking within the global donor community about road traffic injury prevention as a public health objective. The larger spread of health targets

included in the SDGs, compared with the relatively narrow focus of the MDGs, should in theory result in a more proportionate share of available global funding to different health issues. As recent research by the Institute of Health Metrics and Evaluation (IHME) shows, the MDGs were accompanied by an unprecedented increase in both development assistance for health (DAH) and overall global health funding (IHME, 2014). In 2013, DAH spending amounted to US$31.1 billion, five times more than in 1990. The IHME 'Financing Global Health' report finds that this development assistance has been overwhelmingly focused on meeting the MDG targets: "Rapid growth was largely driven by massive investments aimed at advancing these goals, including the fight against HIV/AIDS, malaria, tuberculosis, and child and maternal mortality, realized in the establishment of public-private partnerships", IHME concludes. By comparison non-communicable diseases received just $377 million (although the share is rising) while funding for injury prevention is so low that it doesn't even merit its own line item.

Health financing can play an important role in catalysing global road safety, as the contribution made by Bloomberg Philanthropies since 2010 demonstrates (Bloomberg Philanthropies, 2014). By including a road safety target within the health objectives of the SDGs, governments are recognising the scale of the health burden – which ranks alongside HIV/AIDS, Malaria and Tuberculosis. Few road safety activists would argue that road safety needs the multi-billions of dollars of international aid that these other global killers receive. But there is certainly a compelling case for significantly increasing DAH for this neglected epidemic of road traffic injury. However, in order to secure health funding, the road safety community needs to do a better job of explaining the impact of road traffic injuries and the costs of trauma care on the health sector in developing countries, and needs to be more imaginative about connecting road traffic injury prevention solutions to other health agendas.

For example, there should be a strong communality of interest between action to reduce non-communicable diseases and tackle the obesity epidemic, and action to improve road safety and provide safe, accessible infrastructure for pedestrians and cyclists (WHO, 2014). The same is true of health-related strategies to improve urban air quality and respond to climate change (Commission on Climate and the Economy, 2015). The Intergovernmental Committee of Experts on Sustainable Development Financing has recommended 'mobilizing all resources in an integrated manner' (UN, 2014). In this spirit here are strong alliances that can be built between road safety and those advocating for and funding a range of pressing health, social and environmental issues.

Building the health case for transport investment

Making a strong health case for investment in road safety is also key to securing large scale, sustained funding for road safety from the public and private sectors at national level. The transportation sector, whether through government infrastructure investment, private sector financing, or a combination of the two, is where the majority of spending that will define the safety of roads is, and will continue to be, sourced. Unlike many health issues, which have a direct line of accountability from government to implementing health agency to health outcome, road traffic injuries are a health issue solved primarily by transport planning, infrastructure and vehicle engineering, and police enforcement solutions. Accountability and ownership are diffuse, and too often no one claims full responsibility. Broader mobility or economic objectives (like shorter travel times on higher speed roads) can contradict, and be prioritised ahead of, road safety needs.

More must be done to close the circle between transport, health and finance decision-makers by more effective measurement and communication of the cost-effectiveness and impact of road safety interventions for improved health outcomes and reduced health sector costs. The narrative needs to move away from considering safer road design and related measures as an optional extra 'cost', instead recognising an integrated road safety approach as an essential investment by properly calculating, and allocating its benefit, to human health. Research already shows that road traffic injury interventions are a cost-effective way of reducing Disability Adjusted Life Years (DALYs) (Bishai & Hyder, 2006) and as such have a valid part to play in reducing the overall health burden. We know that targeted interventions such as improved road design on 'high risk' roads in lower income countries can have a benefit to cost ratio of more than 10 (iRap, 2013). The challenge is to persuade the transport and finance ministry that it is worth investing a bit more today in order to reap rewards in health cost savings tomorrow.

Working towards realising the true value of road safety investment is the purpose of the FIA Foundation's 2015 report '*Breaking the Deadlock: A social impact investment lens on reducing costs of road trauma and unlocking capital for road safety'* (FIA, 2015), commissioned from Social Finance and Impact Strategist, and the work-stream on social impact investing for road safety that it launched. Social Impact Bonds and other 'innovative financing' mechanisms may play a role in releasing new sources of primarily private sector funding (and development bonds could also be an effective way to deliver health objectives in low-income countries in the area of road safety). In the context of the SDGs, public/private 'blended financing' of this kind is recommended for consideration by the Intergovernmental Committee of Experts on Sustainable Development Financing (UN, 2014) and in the Addis Ababa Action Agenda agreed at the Third International Conference on Financing for Development in July 2015 (UN, 2015).

But the Social Finance/Impact Strategist report also suggests that the discipline of designing a project that meets the exacting expectations of a private investor, structured in a way that makes transparent the different types of social beneficiary so that metrics - on which repayment schedules would be predicated - are clearly defined, would identify the health and social benefits of a road safety scheme in a

way to transparently demonstrate value for money. Early results from research and data analysis being undertaken in Australia and Cambodia as part of the FIA Foundation's social impact project suggest the argument will be compelling.

Engaging new partners and donors

In many ways the global road safety community is well prepared for the SDGs. As a result of the work that went into securing and promoting the UN Decade of Action for Road Safety, it has a series of UN General Assembly resolutions (the latest being debated in April 2016) recognising the scale of the problem, and mandating some areas of action; it has a Global Plan which provides a basic roadmap for international, regional and national strategies; it has a 2010 baseline of road traffic fatalities from which to measure progress, and the bi-annual WHO Global Status Reports to provide that measurement (WHO, 2015); it has a small, but active, core of governments, in evidence at the 2nd High Level Conference on Road Safety, held in Brasilia in November 2015, which have worked to support and advance each new step forward.

A vibrant UN Road Safety Collaboration, including governments, multilateral institutions, NGOs, foundations and private sector companies, acts as a loose coordinating and motivational body and meets – hosted by WHO – twice a year (http://www.who.int/roadsafety/about/en). There is an increasingly organised and vocal NGO Alliance, providing vital civil society pressure nationally and internationally (http://www.roadsafetyngos.org) and there is now a UN Special Envoy for Road Safety, appointed by the Secretary General, with a mandate to "mobilize sustained political commitment towards making road safety a priority; to advocate and raise awareness about the United Nations road safety legal instruments; share established road safety good practices; and generate adequate funding for advocacy efforts through strategic partnerships between the public, private and non-governmental sectors" (see UN announcement at http://www.unece.org). In 2015 the #SaveKidsLives campaign, built around a 'Child Declaration' and involving hundreds of NGOs and many private sector companies, demonstrated the growing maturity and reach of the global road safety community. The campaign succeeded in attracting more than a million signatures for the Child Declaration, and in 2016 is renewing the effort by focusing on holding governments and institutions to account for delivering the SDG target (www.savekidslives2020.org).

Because the challenge now is to build on these hard-won achievements by expanding the circle of bilateral donors, institutions and agencies, health foundations and private sector partners willing to work for and invest in global road safety, and ensuring that road traffic injury prevention is mainstreamed as part of new policy frameworks, including national reporting frameworks, and financing mechanisms established to deliver the SDGs. (see https://sustainabledevelopment.un.org/index.php?menu=1556 for further detail). What are the steps needed to make this happen?

Firstly, we need to secure greater efforts by institutional leaders to cheerlead for road safety and build higher level and sustained political attention. While WHO's Director General Margaret Chan attended the Brasilia High Level Conference and spoke about the urgency of action (Chan, 2015), road safety remains an issue on the margins of her organisation. Similarly, while the President of the World Bank, Jim Kim, has spoken of the need for action on road traffic injuries (Kim, 2013), such interventions are extremely rare. UNICEF has only recently begun to engage, despite road traffic crashes being a leading cause of death for children and the number one cause of death worldwide for adolescents (UNICEF, 2015). Yet ensuring action at national level, particularly in developing countries with many competing and pressing social and health concerns, relies on a positive feedback loop with global policy leaders constantly reinforcing the need to act.

The global road safety community also needs to further develop the strong evidence base and practical examples of scaled interventions that will persuade bilateral donors, public health foundations and the private sector to join, or launch, efforts for road traffic injury prevention. Wherever possible the global road safety community should seek to identify synergies with other SDG objectives. Social impact investing, with its requirement for transparent metrics, could facilitate development of a clear model of health and other social benefit outcomes.

Practical initiatives, able to demonstrate proven results and positioned to collaborate effectively with partners beyond the traditional global road safety community, are a priority. Some such well-established programmes exist, and have been discussed above. Typically they have benefitted from long-term strategic philanthropic support, which enables staff and expertise to be developed and allows time to prove theories, build networks in developing countries, and demonstrate real delivery. This is the case, for example, with both iRAP and Global NCAP.

For the FIA Foundation, a key priority is to develop a similar approach in the area of child health, focusing on particular areas which impact on the way children use transportation and streets. This includes speed legislation and traffic enforcement; provision of safe infrastructure such as sidewalks and crossings; attention to the quality and affordable availability of school transport; and promoting safe and healthy journeys to school – whether travelling on foot, by bicycle, by bus or on a motorbike or in a car. The FIA Foundation is working with several partners, such as UNICEF, UNEP and the World Resources Institute to realise this objective (see www.fiafoundation.org; www.unep.org or www.wrirosscities.org/news/wri-ross-center-and-fia-foundation-announce-partnership-make-cities-safer-design for more detail on these initiatives).

A Global Fund for road safety

To encourage donors to invest strategically, the global road safety community should offer a united front, and an obvious place to convene. There is currently discussion, led by the UN-ECE, on developing a new UN global fund

that can provide a secure destination for new funds with high standards of governance and accountability; a strong strategic direction for catalytic capacity building efforts; and the credibility to succeed as a broad-based multi-donor platform. This new fund, if approved, could complement or integrate the work of the Global Road Safety Facility, which has achieved a significant leverage effect with core resources of less than $3 million per year.

Whatever framework emerges to coordinate catalytic financing for road safety, a priority should be to coordinate with other relevant financing mechanisms designed to support implementation of the SDGs. The new World Bank Global Infrastructure Facility (World Bank, 2014); the Global Environment Facility, with a remit for partnering on urban design and sustainable transport (www.thegef.org/gef/climate_change) and the new Africa50 Infrastructure Fund (www.afdb.org), for example, should be potential partners for joint funding initiatives or technical partnerships. Integrating road safety expertise into the operations of these major SDG financing mechanisms would release new funding flows for road traffic injury prevention and improve the quality and investment return of infrastructure projects.

With an agreed global fund in place, there will be an urgent need to build on road safety's inclusion in the SDGs by launching an unprecedented fundraising campaign to secure new large-scale pledges for catalytic road safety. The new 'FIA High Level Panel for Road Safety', mainly comprised of influential global business leaders, has the potential to be a powerful fundraising voice reaching an audience of global CEOs and political leaders (www.roadsafety2030.com). The proposed UN Conference on Sustainable Transport and the Habitat III Conference both in 2016; (see https://sustainabledevelopment.un.org/topics/transport and www.habitat3.org); international business and development fora such as the World Economic Forum and Clinton Global Initiative; as well as the on-going SDG events and processes can all provide high impact policy opportunities to promote the case for financing global road safety.

Conclusion

Being part of the SDGs brings real opportunities to integrate road safety with other agendas, particularly in relation to health, cities and the environment, and to demand stronger political commitment to achieve the new SDG targets. New pledges of financial support for international catalytic activity to support sustained national action must be one outcome. This will be best achieved by providing clear evidence of the health and related economic benefits of road safety interventions; and using this evidence to fundraise for strategic and coordinated action, delivered through a credible global fund. Practical, evidence-based initiatives, particularly those that straddle multiple policy areas and integrate road safety into wider (and better financed) agendas, should be well positioned to capitalise on the exciting new opportunities which these Global Goals present.

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Road Safety: a step towards achieving the Global Goals

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Summary

Business as usual is not an option if the International Community is to succeed in delivering the Global Goals. Target 3.6 on Road Safety requires a significant uplift in pace of work, a geographical focus that is appropriately balanced between low income and middle income countries, different partners (including climate change and urbanisation networks), different ways of working (particularly with a focus on girls and women) and strong leadership from WHO to ensure a co-ordinated approach that learns from current research and builds on existing evidence.

Introduction

The Global Goals for Sustainable Development give us a framework to work towards eradicating poverty. The Global Goals came into effect to achieve an end to poverty, combat climate change and fight injustice and inequality by 2030. Goals 3, 9 and 11 have transport related targets. Inclusion of target 3.6 (under Goal 3 Health: Ensure healthy lives and promote well-being for all at all ages): "*By 2020, halve the number of global deaths and injuries from road traffic accidents"* is an acknowledgement of the importance of road safety in delivering the Global Goals.

The UK Government's Department for International Development (DFID) leads the UK's work to end extreme poverty. We're ending the need for aid by creating Jobs; unlocking the potential of girls and women; and helping to save lives when humanitarian emergencies hit. DFID works directly in 28 countries across Africa, Asia and the Middle East.

The UN states that *'If we are to achieve the Global Goals by 2030 we must start by empowering girls and women. Goals that work for women and girls are goals that will work for the world'.* This is a priority for DFID. To achieve the Global Goals and focus on girls and women the transport community will therefore need to increase focus of delivery of road safety and transport more broadly.

Road safety as a priority

The facts and figures speak for themselves. A few examples to highlight are noted below:

- Road crashes claim 1.25 million lives and injure 78 million people each year - many remain disabled for life. The vast majority of casualties occur in low and middle income countries; many are children.
- Road accidents are the leading cause of death for young people aged 15-29 globally.
- 90% of road crash deaths occur in low and middle income countries (World Health Organisation 2009).
- Road crashes now kill more people each year than HIV, tuberculosis, or malaria (World Bank and University of Washington, 2014).
- The recent WHO report on "Preventing disease through healthy environments" shows unintentional injuries, including road traffic deaths, as one of the top three causes of environment-related deaths (WHO, 2016).

The WHO Status Report 2015 highlights that the situation is worst in low-income countries, where rates are more than double those in high-income countries and where there are a disproportionate number of deaths relative to the (lower) level of motorisation. Specifically on the issue of geographical focus the data in the 2015 WHO Status Report shows that LICs now have worse fatality rates than MICs. This was not the case in the 2010 Status Report and, with this new data, the work of key global road safety players should be balanced appropriately between LICs and MICs.

Officially launched in May 2011, the UN Decade for Action on Road Safety is now at its mid-point in time but not progress. The Global Goal target 3.6 on Road Safety is set to galvanise action and the pace of delivery.

Improved transport sector leadership and co-ordination

Getting to zero poverty by 2030, means doing more and larger economic infrastructure investments in the poorest countries. It means reaching the remote rural poor and working in the most difficult environments. In order to deliver tangible improvements in road safety and on sustainable transport more broadly, the transport sector needs to be co-ordinated and accountable.

There is a strong need for sector wide leadership, coordination and accountability across transport at a global level. Without agreed roles and responsibilities, indicators and monitoring frameworks along with sufficient funding to implement road safety measures, it is unlikely the Global Goals and targets will be achieved.

DFID convened a high level transport meeting in March 2015 where Multi-lateral Development Banks and five bilateral donors discussed the need for a sector wide narrative and improved global sector leadership and co-ordination. DFID suggested the sector could look to other sectoral experience and models for co-ordination, such as the Sustainable Energy for All (SE4ALL) initiative that was set up in 2011 with high level UN and World Bank backing. SE4ALL is currently developing a monitoring framework for the energy Global Goal. A preliminary draft sector narrative from the DFID hosted high level transport meeting was submitted to the UN-High Level Advisory Group on Sustainable Transport (UN-HLAG ST) in June 2015.

The UN-HLAG ST was established in 2014 and is mandated to provide global recommendations on sustainable transport (including relating to the Global Goals). Whilst progress has been slow, in January 2016 it appointed a small group of experts to draft the Global Outlook Report which is due to be launched by November 2016. The UN-HLAG has the potential to make far reaching recommendations for transport on global aid architecture, narrative and monitoring. Although broader than Road Safety a more co-ordinated and informed global transport sector would have significant efficiencies for Road Safety.

An example of why it is important to have a co-ordinated and informed overview of the transport sector is that significant changes in key players' priorities and the corresponding financing decisions could be planned for and mitigated.

Case study: European Development Fund

The European Development Fund (EDF)11 has an aid budget of €30.5 billion covering both national and regional programmes. Previous EDFs have provided significant resources to support transport. Changes to EDF policy priorities have seen a withdrawal from transport in national programming from 25% to 10% of total EDF 11 funds. The Official Development Assistance (ODA) contribution from the EC has been significant in the transport sector, in reducing the EDF 11 transport portfolio the global ODA contribution for the transport sector is likely to be significantly reduced.

How this will impact on transport more broadly and road safety specifically is yet to be defined. A forward leaning and informed transport sector could work together to understand and better manage significant sectoral changes.

Poverty eradication and economic growth

Worldwide over 1 billion people lack access to roads and transport services, 98% of them in developing countries. This is a major barrier to eradicating poverty and building shared prosperity. Where populations are dense the problems are different. A reliance on cars leads to congestion and pollution which in turn reduces investment opportunity, service efficiency and increases demands on asset management.

Women and girls are especially disadvantaged. Their domestic roles and responsibilities require frequent trips; they also have less access to private vehicles and reliable public transport or intermediate means of transport. By providing affordable, safe transport services in rural and urban areas countries can empower members of the population to engage in economic and social activities. Based on the large majority of drivers killed being male (though risk exposure is no doubt a factor), road safety itself may also be improved by encouraging more female drivers.

Sustainable, safe transport is about creating new opportunities. It enables businesses to grow, generates jobs, and creates new markets. Countries can grow in an inclusive, resilient, low carbon way, and improve their economic competitiveness without potential profits being eroded by excessive transport costs, including the cost of road crashes.

Systematically integrating safety into transport programmes is key. More efficient transport and sustainable infrastructure and services can have a positive impact on economic development. However, increased road accidents and fatalities can be an unintended outcome of transport interventions unless safety is effectively integrated into the design, planning and implementation. Road Safety should therefore be an essential safeguard component in transport programmes. We already know this and, in many circumstances, we know the solutions. Safe design is as important for roads, as it is for buildings, dams, and other infrastructure however road safety is frequently an afterthought and increased fatalities or injuries an unintended outcome.

Enabling green, liveable, inclusive, safe and competitive cities

A total of 70% of the global population is forecast to live in a city by 2050 (WHO, 2014). Between 2000 and 2030, the urban populations of emerging economies will double

from 2 to 4 billion people. The built-up area of cities worldwide will triple from 200,000 to 600,000 square kilometres. Such rapid population growth accompanied by an even faster spatial expansion of cities may lead to low-density development dominated by individual-vehicle transportation which is a largely irreversible pattern (World Bank, 2013).

If cities are well planned they can be "compact, connected and coordinated" and can function as "engines of growth" contributing to economic development, job creation, poverty reduction and potentially a reduction in road accidents (Global Commission on the Economy and Climate, 2014). An integrated and sustainable approach towards urban mobility can help cities realise their economic potential (Kumar and Agarwal, 2013), taking into account different transportation modes; promoting urban transport policies and efficient mass transit; appropriate facilities for walking and cycling; and smart logistic concepts. This integrated and planned approach will also have significant benefits for improved road safety.

DFID's work on road safety

As part of DFID's contribution to supporting the Global Goal target on road safety we work at a number of different levels. DFID country offices work on road safety with partner Governments where we support transport programmes. These are specific to the bilateral engagement in country. An example is in Nepal where we have complemented a World Bank programme of transport infrastructure with road safety interventions. Internationally DFID funds the World Bank housed Global Road Safety Facility (GRSF), along with Bloomberg Philanthropies and FIA Foundation. GRSF is assisting LICs and MICs across a wide range of interventions: from seed-funding and technical assistance to advisory services, capacity building, training and knowledge development. In Nigeria, GRSF technical assistance in management capacity, infrastructure safety and road safety enforcement to the Federal Road Safety Corps has yielded an 11% reduction in deaths along project corridors which have seen an increase in traffic flows. DFID chairs the GRSF Board.

DFID funds a number of applied research programmes on transport and each has a theme or cross cutting area that supports research on Road Safety. These include the applied research programme (ReCAP) on low volume rural roads which currently works in nine African and three Asian countries (for further detail see http://research4cap.org/SitePages/Home.aspx).

Looking forwards

Transport faces huge challenges more broadly and in the sub-sector of Road Safety in particular. The context is rapidly evolving. Working with new partners and the utilisation of new technologies for recording, collecting, analysing and communicating road safety information is essential.

The Asian Infrastructure Investment Bank (AIIB) is likely to be a large player in Asia on economic infrastructure, and has to date received US$98bn in financing commitments. The New Development Bank (formerly known as the BRICS bank) also has a clear infrastructure mandate, and is likely to have a similar capitalisation as AIIB. The road safety community must work more closely with these new and important players.

In developed and emerging economies digital technologies are opening new fields of opportunities and revolutionising the transport sector by modifying historic business models, creating new uses and new practices (car sharing, car-pooling, etc.), generalising real-time user information and data collection, and offering efficient tools to improve the effectiveness of traditional transport networks. The road safety community needs to capitalise on technological advances and look for innovative ways to combat road accidents.

Developing countries can opt for a very different development paradigm compared to many industrialised countries that are often locked into costly, high-carbon transport systems largely based on private motorised transport. Greenhouse gas emissions can be decoupled from urban transport development by providing efficient, equitable mass transit and incorporating non-motorised transport in land use planning and urban governance. The road safety community could continue to build strong partnerships with the climate change movement and look for mutually beneficial decoupling of both greenhouse gas emissions and road accidents from increased transport infrastructure.

The failure to integrate road safety into urban and broader transport planning and programmes results in huge human and economic costs. To reduce these costs those working in the transport and related sectors must work differently. This includes:

- **Enhance portfolio flexibility and agility**: Be agile in the approach to new challenges (including climate-smart design, resilience, urbanisation, emerging technologies and financing); be responsive to, and facilitate, political appetite for reform; and help countries take a strategic approach to road safety investments.
- **Maximise opportunities for women, girls and the poorest**. Support female economic empowerment through consultations in transport programme design; ensure equitable access to safe transport services; and address risks of vulnerability (e.g. road safety).
- **Strengthen leadership, coordination, accountability**. Embed incentives for working together on road safety at global and country levels based on a common vision for the transport sector; ensure the geographical focus of road safety reflects the worsening situation in LICs; adopt sector-wide and project specific indicators which track value for money, inclusive growth and jobs; share data and information to reduce costs; and improve mapping of sector financing changes.

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Global enhancement of vehicle safety - the urgency of now

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Introduction

The United Nations (UN) Global Goals for Sustainable Development have set the ambitious goal of reducing road fatalities and serious injuries by 50% by the end of the current UN Decade of Action for Road Safety (2011-2020). The Global Goals represents the UN's strongest ever mandate for action to promote road safety and provides new urgency in the implementation of the Global Plan for the Decade of Action, which recommends actions across the five policy areas of:

- Pillar 1: Road safety management
- Pillar 2: Safer roads and mobility
- Pillar 3: Safer vehicles
- Pillar 4: Safer road users
- Pillar 5: Post-crash response

Under Pillar 3, UN member states are encouraged to apply requirements to ensure new vehicles have seatbelts and anchorages installed that meet regulatory requirements, pass applicable crash test standards and support the adoption of crash avoidance technologies such as Electronic Stability Control (ESC). In April 2016, the UN General Assembly adopted a resolution which included a strong section on vehicle safety, inviting member states that have not already done so to adopt minimum safety standards and safety technologies, providing further endorsement for the importance of safe vehicles.

Safe vehicles is an important pillar under the Safe System approach to road safety and its safety potential in reducing serious trauma by preventing crashes and protecting occupants is well supported (Newstead et al, 2004). Safe vehicles is amongst the most sustainable road safety intervention available as once a vehicle is designed and manufactured to a safe safety standard and has the appropriate technologies, the safety benefits should continue to accrue throughout the life of the vehicle. It is therefore concerning that there is still a large number of countries that do not apply at least minimum safety standards for vehicles produced and sold; allowing sub-standard cars to be made available to the public.

While significant gains have been made in vehicle safety in high income countries, the same cannot be said in the low and middle income countries who are experiencing rapid increases in motorisation but also account for 90% of global road deaths (WHO, 2015). There is an urgent need to democratise safety globally through the universal application of minimum vehicle safety standards and empowering consumers to purchase the safest car they can afford. Every vehicle sold that does not meet at least minimum safety standards is an opportunity lost. Therefore, with the 2020 goal in mind and with the long lead time for the penetration of technologies and replacement of the vehicle fleet, the time to act is now.

The need for universal application of minimum vehicle safety standards

Not all cars are created equal and some are safer than others. This can be a function of the vehicle safety regulations of the producing country. While the UN World Forum for Harmonisation of Vehicle Regulations provides a legal framework for a range of vehicle safety standards for UN member states to adopt voluntarily, many countries

do not. It was found in a recent survey that only 40 out of a total of 193 UN Member States fully applied seven priority vehicle safety standards recommended by Global NCAP (WHO, 2015). The seven standards (or their equivalents) included:

- UN Regulation 94 Frontal Impact
- UN Regulation 95 Side Impact
- UN Regulation 13H Electronic Stability Control
- UN Regulation 127 Pedestrian Protection
- UN Regulation 16 Seat Belts
- UN Regulation 14 Seat Belt Anchorages
- UN Regulations 44 and 129 Child Restraints

Results from the survey showed that adoption of the standards was overwhelming by high-income countries (Figure 1). This is despite, large middle income countries accounting for approximately 50% of passenger car production globally (Organization of Motor Vehicle Manufacturers, 2015) and the fastest growth in motorisation.

The lack of universal adoption of the minimum standards creates a loophole in which manufacturers can produce and sell sub-standard cars in countries that have not applied the standards, typically in low and middle income countries. Some examples include:

- Chevrolet Aveo, a best selling car in Mexico received a zero star rating by Latin NCAP in 2015. The car did not have airbags fitted and would have failed the UN's minimum vehicle safety standards (Latin NCAP, 2015).
- Suzuki-Maruti Alto 800, a best selling car in India received a zero star rating by Global NCAP in 2014. The car did not have airbags fitted and would have failed the UN's minimum vehicle safety standards (Global NCAP, 2014).
- Nissan Tsuru, a top selling car in Mexico, which received a zero star rating by Latin NCAP in 2013 did not have airbags fitted and would have failed the UN's minimum vehicle safety standards (Latin NCAP, 2013).

All three of these cars would have been illegal for sale in countries that have more stringent regulations such as in Australia, Europe or the USA; demonstrating the urgent need for governments around the world to apply these standards. Road safety is a shared responsibility and while governments have the responsibility to ensure their citizens have access to safe vehicles, manufacturers also have a responsibility to ensure their vehicles are safe for consumers. Even in the absence of regulatory requirements, it is still unacceptable that unsafe cars are being produced in low and middle income regions when it is evident that much safer standards can be reached by the same manufacturers in more affluent regions.

It has been argued that it can be too expensive to apply UN regulations and vehicle technologies resulting in unaffordable cars in the low and middle income countries. However, with the growing use of global manufacturing platforms and economies of scale, increasing the safety of a vehicle is not prohibitively expensive and actually very affordable. For example, a typical price of an airbag, a key safety feature to pass Regulation 94, sold by suppliers cost only approximately $50 (Global NCAP, 2015).

There is no doubt that if at least minimum vehicle safety standards are universally applied, countless lives can be saved. A report commissioned by Global NCAP found that if Brazil was to apply the UN Regulations for seat belts, anchorages, occupant protection in frontal collision and occupant protection in side or lateral collisions, over 34,000 lives could be saved and 350,000 serious casualties prevented between 2015-2030 (Cuerden et al, 2015), demonstrating the lifesaving potential of standards application.

The role of NCAPs in global vehicle safety

In parallel to regulatory action, increasing consumer knowledge and demand for vehicle safety and technologies have been an important part of the equation in enhancing vehicle safety globally. Consumers cannot demand what they do not know and NCAPs play an important role in assisting car buyers to make safer purchasing decisions by providing them with independent safety advice which in turn encourages manufacturers to produce safer vehicles. NCAPS also play a role in encouraging manufacturers to voluntarily fit safety technologies in advance of any regulatory mandate and produce safer vehicles.

Since the inception of the first NCAP in 1978, there are currently

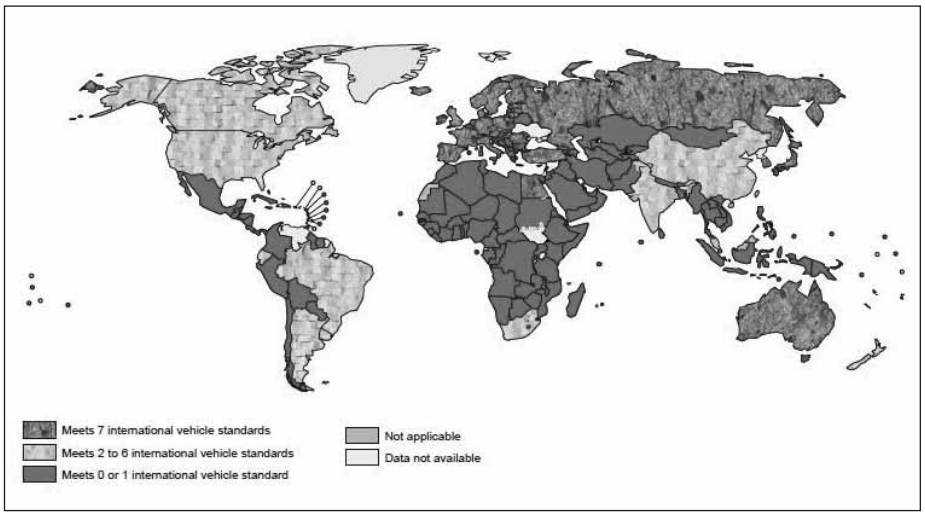

Figure 1. Countries Applying Priority UN Vehicle Safety Standards (WHO, 2015)

nine NCAPs worldwide in Asia, Australia, Europe, Latin America and the USA. NCAPs have been highly successful in influencing the supply and demand for safer vehicles and increasing the proportion of vehicles achieving better performance. An example is Australasian NCAP (ANCAP), where in 2002, no vehicles tested achieved a 5 star rating to 2014 where 75% of models on sale achieved a 5 star rating (Paine et al, 2015). With the improvement of a 1 star ANCAP rating associated with a 20-25% reduction in the risk of serious injury to the driver (Paine et al, 2013), encouraging consumers to purchase the safest vehicle they can afford and putting pressure on manufacturers to produce safer vehicles via NCAPs can go a long way in helping reduce deaths and serious injuries. This is an especially important consideration in regions that have rapid increases in motorisation and no minimum vehicle safety regulations. With the lack of minimum safety standards, consumers have no guarantee that the vehicle they purchase will at least afford them a basic level of safety and NCAP testing fills this knowledge gap. NCAPs inform consumers that safety is not just a luxury option and a safe car does not necessarily have to be unaffordable, as demonstrated by the Perodua Axia which cost US $8000 and achieved four star occupant and child protection results under the Southeast Asia vehicle assessment program, ASEAN NCAP (Global NCAP, 2015). While star ratings are not equivalent between the NCAPs, in all test programs, the higher the number of stars, the safer the vehicle for that region. A key element to enhancing vehicle safety globally is to expand NCAP testing to every world region and increase access to independent crash testing information to stimulate the demand for the production and purchase of safe vehicles.

Democratising vehicle safety – no more zero star cars

In March 2015, Global NCAP, the coordinating platform between all the NCAPs and advocate for the development and adoption of polices that enhance and accelerate the progress of vehicle safety globally, published 'Democratising Car Safety: Road Map for Safer Cars 2020' (Global NCAP, 2015) which calls for the combination of stronger consumer information and universal application of minimum international standards for crash protection and avoidance. The road map sets out a strategy to ensure vehicle safety is democratised in all world regions with ten key recommendations which include a package of minimum safety regulations for adoption by the end of the UN Decade, measures to promote a market for safety among consumers in rapidly motorising countries, policies to sustain the safety of the vehicles once in use and a proposed industry voluntary commitment to implement minimum occupant safety standards to all new passenger cars (refer to Figure 2). If the recommendations in the Road Map are applied, all new cars worldwide would pass the minimum UN Standards for crashworthiness and crash avoidance and there will be no more zero star cars produced, helping mitigate the risks of rapid motorisation and reduce the number of preventable fatalities and serious injuries globally.

Road Map for Safer Vehicles 2020 UN Regulations* for:	All New Vehicles Produced or Imported	All Vehicles Produced or Imported
Frontal Impact (No.94) Side Impact (No.95)	2016	2018
Seat Belt & Anchorages (No.14 & 16)	2016	2018
Electronic Stability Control (No. 13H / GTR. 9)	2018	2020
Pedestrian Protection (No.127 / GTR. 8)	2018	2020
Motorcycle Anti-Lock Brakes (No. 78 / GTR. 3)	2016	2018
Autonomous Emergency Braking Systems	Highly Recommended	Highly Recommended

*or equivalent national standards such as US FMVSSs

Figure 2. Global NCAP Road Map for Safer Vehicles by 2020 Timeline

Help #STOPTHECRASH

The crash prevention and crash protection properties of a vehicle are both critical elements in helping protect occupants and other road users from death or injury, but where possible, preventing a crash from occurring would always be the preferable option. There are a number of crash avoidance technologies available that can prevent many types of crashes before they happen with proven real world effectiveness, including ESC, Autonomous Emergency Braking (AEB) and Motorcycle Anti-lock Braking System (ABS). To support the UN Global Goals and the Decade of Action, Global NCAP is leading a multi-stakeholder partnership (with ADAC, Autoliv, Bosch, Continental, Denso, Thatcham, ZF-TRW, the Towards Zero Foundation and Consumers International) called Stop the Crash to promote these three lifesaving crash avoidance technologies and tyre safety. The campaign's objective is to encourage governments to adopt relevant UN global standards so that the technologies eventually become a regulatory requirement for new vehicles. The inaugural Stop the Crash event was launched in Brasilia on the occasion of the 2nd Global High Level Conference on Road Safety in November 2015 (Figure 3) and more major events are planned to raise awareness and increase adoption and purchase of these technologies.

Figure 3. Stop the Crash Demonstration in Brasilia 2015

Conclusion

A vehicle's lifespan is approximately 20 years and it takes on average at least 15 years for a vehicle fleet to be completely replaced. Therefore, every vehicle sold that does not meet the best safety standards and are not equipped with the best safety technologies as currently known, represents an opportunity lost and the vehicle will continue to operate at greater risk for the rest of its lifespan. There is an urgency for prompt action now as with every year of delay, the millions of sub-standard vehicles produced will remain on the road for decades to come. Vehicle safety should not be an optional extra and people in all regions of the world should have access to safe vehicles. The right actions taken now will ensure a safer vehicle fleet for all in the years ahead.

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The role of GRSP in global road safety and priorities for achieving ambitious road fatality reduction targets

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Introduction

Although road trauma has been acknowledged as a humanitarian issue since the late 1990s, it has struggled to be recognised as a global priority. One of the first global-level reports to give attention to the issue was the International Federation of the Red Cross and Red Crescent Societies' (IFRC) World Disaster Report 1998. While this contributed to the establishment of the Global Road Safety Partnership (GRSP), it did not lead to a global level response. A major step forward occurred in 2011 when the United Nations established the Decade of Action for Road Safety (2011-2020). Besides representing the first truly global response to the issue, it was supported by a Global Plan that specified a road fatality reduction target and established a framework for action around five pillars involving: building road safety management capacity; improving the safety of road infrastructure and broader transport networks; further developing the safety of vehicles; enhancing the behaviour of road users; and improving post-crash care. Importantly, the Global Plan for the Decade of Action for Road Safety 2011-2020 was built around clear guiding principles including: the need to adopt a safe systems approach to road safety, which acknowledges the limitations and vulnerabilities of humans within the road transport system; the value of a public health approach that focuses on the implementation of evidence-based

interventions; and the importance of promoting ownership of the problem at national and local levels, and involving multiple sectors and agencies (UNRSC, 2011).

The fatality reduction target incorporated into the Decade of Action for Road Safety involved first stabilising and then reducing global road fatalities to 50% of what they were otherwise projected to be in 2020 (UNRSC, 2011). While considered ambitious at the time, there is a growing feeling within the road safety community that five years has now elapsed and the rate of improvement has not been as great as it needs to be.

Encouragingly, global recognition of this need has recently been achieved through the inclusion of road safety targets in the new Sustainable Development Goals (SDGs). A specific stand-alone target in the Health Goal was included to: "By 2020, halve the number of global deaths and injuries from road traffic accidents". In addition, road safety is included within a target on sustainable urban transport in the Cities Goal. The adoption of these goals by United Nations member countries was a landmark achievement for the global road safety community, since the SDGs will guide all global development efforts over the next 15 years in order to "*stimulate action in areas of critical importance for humanity and the planet*" (UN, 2015).

This paper will outline the role of GRSP in global road safety and the strategies it uses to address the global road trauma problem. In addition, it will outline some of the key factors contributing to this problem, along with priorities that will need to be addressed for the ambitious road safety targets captured in both the Global Plan for the Decade of Action for Road Safety and in the SDGs to be achieved.

The role of GRSP in global road safety

In response to the growing awareness of the global road safety problem, GRSP was founded in 1999 as a joint initiative of the World Bank, the United Kingdom's Department for International Development (DFID) and the International Federation of Red Cross & Red Crescent Societies (IFRC). From the beginning, GRSP has been hosted by the IFRC and has had the goal of creating partnerships between government, private sector and civil society organisations to facilitate 'on the ground' road safety activities, particularly in low and middle income countries where the vast majority of global road fatalities occur (WHO, 2015).

Since its foundation, GRSP has established an extensive network of active partners drawn from a variety of sectors. As shown in Figure 1, these partners include:

- a unique network of members comprising government, private enterprise and civil society organisations, who not only provide funding to support GRSP but directly contribute to improved road safety through their organisational policies and practices as well as their community-based activities;
- the worldwide network of 190 National Red Cross and Red Crescent Societies, which GRSP mobilises and supports through being a hosted programme of the IFRC;
- a network of nine independent National Road Safety Partnerships who build local partnerships with government, private enterprise and civil society organisations at the country level;

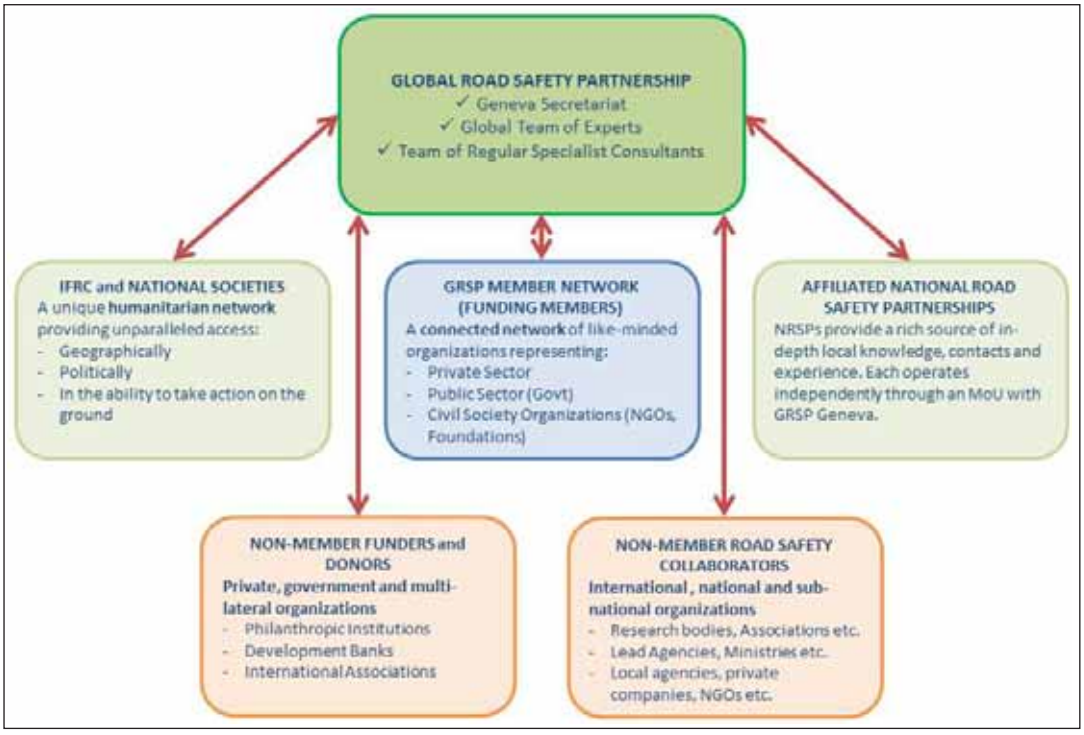

Figure 1: GRSP's Members and Other Partners

- other donors and funders who draw on GRSP's expertise and capacity, such as Bloomberg Philanthropies, the European Union, and the World Health Organization (WHO); and
- a wide range of government and non-government agencies with which GRSP collaborates to advocate for evidence-based road safety policies and enhance national and local capability.

Through this network of partners and funders, GRSP is currently active in over 35 countries around the world (GRSP, 2015). Its direct role in contributing to road safety improvements is exemplified through its involvement in the Bloomberg Initiative for Global Road Safety (BIGRS) (Bloomberg Philanthropies, 2016). In this programme, GRSP's role is two-fold. Firstly, it undertakes a range of activities to enhance the capability of civil society organisations in priority cities and countries to advocate for evidence-based and locally relevant laws and policies. Central among these activities is the administration of a road safety grants scheme. Secondly, it focuses on developing the capability of road safety stakeholders in priority cities and countries to implement evidence-based laws and policies. Central among these activities is the support and advice it provides to policing agencies to plan and deliver good practice road policing operations.

In summary, as a hosted programme of the IFRC and through its extensive network of members and other partners, GRSP contributes to the enhancement of global road safety by:

- Raising global awareness of the humanitarian crisis represented by road crashes and the need for more resources to be devoted to the issue;
- Utilising a partnership model of working with government, the private sector and civil society to optimise resources through shared efforts;
- Drawing on the resources and expertise of our members to deliver evidence-based road safety activities in priority countries and cities;
- Promoting the Safe System Approach to road safety, which underpins the Global Plan for the Decade of Action for Road Safety;
- Advocating for evidence-based and locally relevant policies that protect road users, as well as the necessary systems and practices to ensure that these policies are effectively implemented and maintained;
- Contributing to knowledge about good practice in road safety through a commitment to developing, implementing, and evaluating evidence-based interventions;
- Providing training and professional development for organisations and individuals involved in road safety; and
- Focusing its efforts on low- and middle-income countries, where 90% of the world's road fatalities are estimated to occur (GRSP, 2015).

Factors contributing to the global road safety problem

Underlying the global road trauma problem is the rapid motorisation that has been occurring around the world, particularly among those countries experiencing strong economic growth. In 2013, the WHO reported that there has been a 15% increase in the number of motorised vehicles worldwide since 2007, taking the global fleet to more than 1.6 billion registered vehicles. Middle-income countries were motorising most rapidly, accounting for 52% of the global figure—a substantial increase from 39% just three years before (WHO, 2013). High-income countries accounted for 47% of registered vehicles, and low-income countries just 1%. A major impact of this rapid motorisation was that many countries had not been able to sufficiently invest in improving their road infrastructure to cope with the increased number of motor vehicles, nor adequately protect the vulnerable road users who still need to use the road transport system.

Similarly, many countries experiencing rapid motorisation have not been able to respond quickly enough to implement those road safety initiatives and strategies shown to be effective in stronger performing countries. For example, the adoption of strong laws and related enforcement policies to address the major risk factors of drink driving, speeding, and the non-use of seat belts, child restraints and motorcycle helmets has proven to be highly effective in reducing road fatalities and injuries in many countries. Encouragingly, the WHO reported that between 2008 and 2011, 35 countries adopted additional road safety laws to address these risk factors. However, it remains a major concern that by 2011 only 28 countries had comprehensive laws in place across all five of these risk factors – representing coverage of only 7% of the world's population (WHO, 2013).

Spending on road safety varies across low and middle income countries, but is not generally commensurate with the economic impacts of crashes. Limited resources make prioritising road safety initiatives difficult and there is the risk that road crashes can become seen as '*the inevitable collateral damage arising from economic development*'.

Priorities for the future

In order to achieve the ambitious road safety target in the SDGs, it will be critical for innovative funding mechanisms and solutions to be identified by the road safety community. Road safety is a complex problem, so it will require action on many fronts. However, the GRSP recognises that there are some critical priorities that need to be progressed. The priorities discussed are not intended to be exhaustive, but rather illustrative of the types of efforts that will be required to achieve our collective global road safety goals.

Promoting the widespread adoption of the Safe System Approach

The Safe System Approach is increasingly being recognised as the leading strategic perspective in road safety, underpinning the road safety strategies of many of the best performing countries (UNRSC, 2011; OECD, 2008; Watson & King, 2009). Central to the Safe Systems Approach is the recognition of the vulnerability of humans to injury and that they inevitably make mistakes. As a consequence, the road transport system needs to be transformed to better account for human limitations and to reduce the impact of human error. At a practical level, this requires a holistic and comprehensive approach involving improvements to vehicle safety for occupants and pedestrians, improvements to road environment safety through assessing and treating poor roads, encouraging widespread compliance with road rules and other safe behaviours, and optimising interactions between vehicles and road users, particularly through the management of vehicle speeds.

Despite the Safe System Approach being increasingly adopted at national and subnational levels, challenges remain in operationalising and embedding it into standard road safety policies and practices. It requires a change in thinking for many transport and road safety professionals, who have traditionally focused on improving road safety within a car-centred system where maintaining the mobility of motor vehicles has been a primary goal. In contrast, the Safe System Approach is more focused on promoting 'safe mobility' for all road users, including pedestrians, cyclists and motorcyclists. Another major challenge for low- and middle-income countries is that most of the developments in safe system thinking and practice have occurred to date in high-income countries, so there is a lack of good models for them to apply. As noted below, more research is required to identify safe system practices which can be effectively transferred across countries and different road environments, particularly those that are relatively low cost in nature.

Building partnerships

As noted above, there is no one single answer to solving the global road safety problem, but one very powerful approach is that of using multi-sector partnerships to create sustainable change in road safety results. This was clearly recognised in the United Nations resolution for establishing the Decade of Action for Road Safety where it stated: "*The solution to the global road safety crisis can only be implemented through multi-sectoral collaboration and partnerships*" (UN, 2014). Bringing together all the relevant stakeholders, from business, government and civil society organisations in low- and middle-income countries is a key step for adapting and developing good practice road safety solutions, suitable to context and culture.

The three "voices" of the business, government and civil society each have something unique to bring to help solutions take root. The civil society sector brings the voice of change and societal improvement. The business voice brings experience in target setting and focussed efficiency of action. The government voice brings the ability to enact efficient social change through legislation and enforcement.

The strategic benefit of the partnership approach is that it unites working teams – from the highest levels of government to local schools and villages – towards implementing sustainable, locally owned and managed solutions. The challenges facing the road safety community are great in the years ahead, but by working together through proven good practice, a strong platform can be created for saving lives and reducing the substantial economic and social impacts of road crashes.

The need for more road safety research in low- and middle-income countries

Historically, most road safety research has occurred in high-income countries. In many of these countries, there has been a long history of responding to the road safety problem that has impacted on institutional arrangements, road user behaviour and the culture of road use. However, the lessons learned and good practice from high-income countries will not necessarily transfer easily or automatically to low- and middle-income countries, due to the different cultural, institutional and social conditions existing in those countries. For example, the type of traffic, the mix of road users, and the kinds of road crashes that occur in low- and middle-income countries differ significantly from those in high-income countries. The uneven socio-economic landscapes mean technologies and policies cannot be applied without adaptation.

Consequently, research capability and capacity must be encouraged and developed in low- and middle-income countries, with an emphasis on enhancing road crash data collection and analysis, evaluating new policies and practices, developing models to facilitate transfer of road safety knowledge and experience across countries and supporting the implementation of the Safe System Approach. Further, it is imperative that this challenge is addressed through the promotion of low cost initiatives and fast-tracking the adoption of context-effective technologies.

Conclusion

While road trauma has been recognised as a major humanitarian issue for some years now, the road safety community has struggled to attract the necessary global attention and resources necessary to deal with this complex problem. With the recent inclusion of an ambitious road safety target in the SDGs, an opportunity exists to increase worldwide awareness of the problem and to mobilise new and significant levels of resources and expertise. If this can be achieved, the flow on effects – particularly in low- and middle-income countries – could be substantial and reinforce efforts already underway at national and subnational levels.

Acknowledgements

This paper draws heavily on GRSP's *Road Map*, which is its Strategic Plan for the period 2016 – 2020. Consequently, the author would like to acknowledge the input and assistance of all the staff within GRSP who contributed to the development of the *Road Map*.

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The Multilateral Development Banks´ Road Safety Initiative

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Introduction

Multilateral Development Banks are institutions, created by countries that provide financing and professional advice for the purpose of development. MDBs have large memberships including both developed donor countries and developing borrower countries. This paper represents the work undertaken by the African Development Bank (AfDB), the Asian Development Bank (AsDB), CAF-Latin American Development Bank (CAF), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the Islamic Development Bank (IsDB), and the World Bank (WB).

The MDBs have a long history of supporting road safety in their member countries. The MDBs recognise that collectively and individually, they have been increasing their support for road safety. This includes increased loan and grant financing for road safety investments, and technical assistance for strengthening road safety capacity, policies and institutions in client countries as well as awareness events. However, there is a need to further harmonise their efforts.

On 11 November 2009, ahead of the First Global Ministerial Conference on Road Safety in Moscow, seven MDBs, as listed above, (noting that CAF joined in 2012) issued a Joint Statement on a Shared Approach to Managing Road Safety. The Joint Statement aims to support harmonisation of road safety policies in MDB transport sector operations. The efforts further evolved into the MDB Road Safety Initiative, which aims to ramp up support for the United Nations (UN) Decade of Action for Road Safety, 2011–2020 (UNDoA) and to develop a shared program of engagement in the countries where MDBs operate.

Further efforts were made during the 2nd Global High Level Conference on Road Safety (November 2015) held in Brasilia. The MDBs, led by CAF, published a report on "Upscaling Support and Developing a Shared Approach 2011 – 2015." The report reviewed results of MDBs efforts

in road safety, documented lesson learned, and defined the way forward of the Initiative for the period 2016 -2020.

The UN recently approved 2030 Sustainable Development Agenda has underscored the importance of addressing road safety. As part of Sustainable Development Goal (SDG) 3 ("ensure healthy lives and promote well-being for all at all ages"), a global target has been established to "**by 2020 halve global deaths and injuries from road traffic accidents**" (Target 3.6). In Development Goal 11 ("Make cities inclusive, safe, resilient and sustainable"), a global target has been established to: "**by 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons**".

In order to realise these targets, major efforts will be necessary to address road safety, especially in low and middle-income countries, through targeted action and significant increase in financing provided for road safety programs.

Commitment of the MDBs

One of the key pillars of the UNDoA is safer roads and mobility. This pillar highlighted the need for improved safety in the planning, design, construction, operation and maintenance of transport infrastructure projects and the inclusion of safety in the implementation of infrastructure improvements.

Collectively, in 2014, MDBs approved about US$20 billion of new funding for transport projects (MDB Working Group on Sustainable Transport, 2015), of which the majority of the funding will be spent on road projects. However, this is only a small representation of total investments in transport sector, worldwide. Overall, the total investment needs in road infrastructure alone is over USD 3 trillion annually worldwide.

Roads that are built today are durable assets with typical lifespan of several decades. There is a direct correlation between the quality of the infrastructure that are built today to the scale of the road safety issue over the next decades. As the majority of projects financed by MDBs in transport sector are on road infrastructure; the MDBs have a crucial role in addressing road safety, especially since their financing is targeted to low and middle-income countries where crashes and injuries rates are higher. These countries are rapidly renovating and expanding their road networks to accommodate growing domestic trade and mobility needs, however they are typically done based on old design standards which came from developed countries.

The road networks in low and middle income countries are typically built to accommodate all types of road users; however, there is limited priority on general safety and often a lack focus on vulnerable road users. New roads in these countries have enormous potential to stimulate economic growth and increase living standards, however at the same time they also present higher risks when key safety considerations are omitted in the, planning, design and/or construction phases. These risks can be reduced by prioritising safety and vulnerable road users during design and/or construction of new infrastructure.

The MDBs acknowledged their responsibility in delivering road infrastructure with higher road safety standards. Considering their development agenda, ability to leverage public and private sector funds, and their strong ties with national road authorities; MDBs are in a position to influence governments to advocate for increased safety and better focus on vulnerable road users on the projects that they finance.

In 2009, ahead of the First Global Ministerial Conference on Road Safety in Moscow, the MDBs agreed to jointly leverage country and regional road safety programs to help accelerate knowledge transfer, strengthen institutional capacity and scale up road safety investment, in particular for road infrastructure safety improvements as a key component of the Safe System Approach. To foster this approach, MDBs agreed to share complementary skills and practices that each bank has developed in the following areas:

1. Implementing safety approaches in the planning, design, construction, operation, and maintenance of road infrastructure projects;
2. Strengthening road safety management capacity;
3. Improving safety performance measures; and
4. Mobilising more and new resources for road safety.

Results

MDBs Joint Statement in 2009 provided a useful platform to develop a common framework to achieve the main goal of reducing the global number of traffic related deaths and injuries. In 2011, prior the launch of UNDoA, the MDBs Road Safety Initiative launched "A Development Priority" (see http://siteresources.worldbank.org/INTTOPGLOROASAF/Resources/WB_GRSF_MDB_web.pdf) to establish guidelines on how MDBs can work together, and how it will provide a harmonised platform for countries, regions, and road safety partners for sustained support, guidance and exchange of information on good practices. The Road Safety Initiative have met periodically sharing their individual safety plans, procedures, training programs and finding ways to upscale the investment in road safety, as well as defining road safety indicators.

Based on the work plan agreed by the MDB Road Safety Initiative, the MDBs have scaled up their activities in road safety to ensure that roads are designed with highest standards and to build capacity in their countries of operation, thus bringing a demonstration impact beyond the financing of specific projects.

A major shift in MBDs transport operations between 2011 and 2014 is the inclusion of road safety audits and inspections for all projects financed by MDBs. The MDBs acknowledged that up until 2011 very few projects financed by MDBs were subject to road safety specific screenings and audits, which have major impact on the overall MDBs' road safety goal. As a result of MDBs enhanced focus on road safety, compulsory audits and inspections as well as complementary actions and components were delivered to MDBs transport projects when necessary.

Whilst there are notable differences in MDBs individual mandates, the MDB Road Safety Initiative has demonstrated that a collaborative approach through knowledge sharing, and shared principles in road safety, can deliver safer roads in low and middle income countries. This collaborative approach will continue towards the second half of the UNDoA, in an effort to address gaps found, and achieve the goals proposed by the end of the decade.

MDBs common approach in road safety started with the development of an MDB Road Safety Guidelines (Gomez Velez, 2014). MDBs collectively identified: road safety audits and inspections, identification of risky locations, technical assistance, capacity building, and overall road safety ratings of road networks as the most common and important activities where a guideline must be issued. By 2013, the MDBs agreed to produce the MDBs Road Safety Guidelines to ensure better awareness and integration of road safety in MDBs financed projects and program appraisals. These Guidelines aim to provide a reasonably consistent approach when working in MDBs financed transport projects.

The Guidelines form part of the MDBs joint effort to share tools and procedures on road safety. MDBs recognise that each MDB has a different approach and levels of development on road safety; the document was prepared with a view to allow each MDB to apply their specific policies and strategies (http://publicaciones.caf.com/media/40517/1._road_safety_guidelines.pdf).

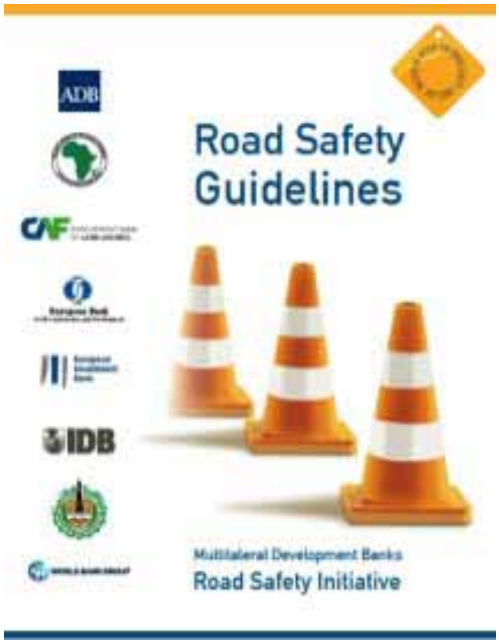

Figure 1. MDB Road Safety Guidelines

The Guideline is recommended for use in projects that generate road safety risks, such as new construction, rehabilitation or upgrading of interurban and urban roads and mass transit and public transport. It also provides a platform for MDBs to promote, assist, and request for road safety specific information on infrastructure projects, such as:

- Road Safety Impact Assessments (RSIA), which include crash data analysis for a single road, road network or area, identification of crash problems, contributing factors and target groups, and establishment of benchmarks for later performance monitoring of a given project;
- Establishment of an effective road crash data reporting and management system to enable targeted road safety work in the future;
- Evaluation of the safety ratings of existing road networks and strengthening of capacity for periodic Road Safety Inspections (RSI) of the road network (black spots, spatial analysis in urban areas and hazardous road sections);
- Application of recognised design standards which are in line with the Safe System Approach;
- Inclusion of road safety specialists in the project planning/design team;
- Road Safety Audits (RSA) from feasibility level to opening of the completed project, carried out by independent, certified road safety auditors, and on post – opening of the project;
- Inclusion of cost - efficient and evidence based road safety solutions for existing roads;
- Inclusion of road safety specifications in the tender documents and focus on provisions for road safety in the terms of reference for supervision consultants;
- Application of the required activities, standards etc. in projects where a national road safety plan exists;
- Inclusion of road safety impacts in the formal economic evaluation roads and transit projects.

The Road Safety Guidelines suggest a two-stage procedure for evaluating a project to be financed as:

Stage 1 Initial road safety screening of a country or a city

Stage 2 Assessment of a specific projects based on the references and evaluation for each project.

In 2014, recognising the need to establish new momentum in road safety, the Working Group on Sustainable Transport (WGST), [consisting of the Head of Transport Sector Group and the eight MDBs], in its capacity as MDBs cooperation mechanism on transport at senior level, took overall responsibility for the MDB Road Safety Initiative, with the existing MDB road safety working group becoming a technical working group reporting to the WGST. This move cements road safety as a main component in the MDBs working group on sustainable transport that leads sustainable transportation towards vision zero.

MDBs recognised that most of MDBs' projects are generally prepared and implemented over long periods. Therefore, the increased focus on road safety in recent years may not be fully materialised until the projects are completed or by the end of the UNDoA.

The real impact of reduction in traffic related casualties will take time, and will be a direct result of several paradigm changes including: the collaborative approach and increased focus on road safety. Further, these efforts will not work in isolation, but they need to be further supported by continued road safety audits, impacts assessments, and continue capacity development of key personnel at the responsible authorities.

More work is still needed to support the goal of the Decade of Action and the Sustainable Development Goals. Until now there is still a lack of demand for road safety projects, which has limited the number and scope of road safety investments. MDBs recognise that the development of in-country awareness and capacity, as well as better data quality and availability are essential. These elements together with additional funds for demonstration projects are considered key to create the needed demand amongst the low-middle income countries in the second half of the decade of action.

Highlights of MDBs achievements in road safety from 2009 are listed below:

- ***Upscaling road safety awareness.*** The nature and magnitude of the road crashes problem is now recognised and given attention by MDBs. The main focus for road safety awareness now needs to be on beneficiaries and clients to create better recognition of the problem and more demand for funding for safety.
- ***Strengthening road safety management capacity.*** MDBs have increased their efforts to build their internal capacity as well as the capacity of beneficiaries and clients. This has been done through road safety capacity reviews, training and specific studies and projects. Furthermore, all MDB's have participated in the development of road safety policies, plans, guidelines and road safety manuals. However, the capacity in recipient countries is still extremely weak and needs to be built up and supported over at least a decade.
- ***Implementation of safety approaches in the planning, design, construction, operation and maintenance of road infrastructure projects.*** MDBs Road Safety Guidelines was launched as a first step toward a more coordinated approach to road safety. Joint road safety activity has also materialised in the field by cooperation between MDBs, both on overall level and on project level.
- ***Improving safety performance indicators.*** A comprehensive set of indicators to track progress on road safety has been developed for all MDBs. The indicators can be applied depending on the nature and scope of projects.
- ***Scale up MDB resources spent on road safety.*** MDBs have increased the funding through technical cooperation and loans.
- ***Knowledge sharing***. MDBs have been actively sharing road safety activities, research and knowledge; and is often the catalyst in knowledge sharing activities.

Gaps

The MDBs acknowledge that gaps still exist and the MDBs need to focus their efforts during the second half of the Decade of Action, and to support the Sustainable Development Goals. From MDBs perspective, the main gaps that must be addressed are:

- ***Mainstreaming road safety in MDBs.*** MDBs still need further work to fully mainstream road safety on the projects they finance e.g. through systematic consideration of road safety impacts as part of the economic appraisal.
- ***Inclusion of Road Safety in MDBs country partnership strategies and sector strategies.*** Countries strategies are the first steps to dialogue with countries, and the first step in positioning road safety in countries. While some countries have included road safety in their partnership strategy with MDBs, many countries still need further encouragement.
- ***Development and implementation of National, Regional and Urban Road Safety strategies and Plans.*** Most of the countries have national road safety plans, but these plans are often not supported by sufficient funding and action. Additional follow up in the implementation of the strategies is needed, as well as the introduction of modern road design standards based on the Safe Systems Approach. Urban and Regional road safety plans are very scarce. Urban mobility plans still privilege mobility from safety.
- ***Improve the quality and implementation of the recommendations of road safety audits and inspections***. Road safety is a new procedure for most countries, and there is a need for development of national procedures, which in some cases need legal changes, training, hands-on experience etc., which needs longer time to materialise. Also standardisation for road safety auditors and their certification is

required for assure of the quality of the procedures.

- ***Support in data collection.*** Good quality data is needed to formulate plans and measure their effectiveness. Many countries lack good data collection and analysis, which is a basic requirement for targeted road safety work.
- ***Mobilising more and new resources for road safety.*** More road safety components in transport projects, stand-alone road safety projects are needed.
- ***Not enough capacity among authorities and stakeholders.*** Lack of capacity is often due to lack of awareness among authorities and stakeholders. National road design standards are often far from the Safe System Approach, and may also be in conflict with the recommendations of safety audits, which make it difficult for authorities to follow audit recommendations.

Moving forward

Since the launch of the MDBs initiative in 2011, MDBs have evolved from partially embracing road safety to full inclusion of road safety considerations in transport sector projects, including establishing a common approach in road safety. MDBs have collectively and individually progressed mainstreaming road safety in their transport portfolio and in raising awareness on the importance of building safe roads. Nevertheless, it is important to recognise that in order to realise the global targets; major efforts are needed to address road safety in developing countries. This includes improved understanding of the road safety challenges, application of targeted safety measures, and significant increase in funding provided for road safety programs.

In order to address the gaps found and recognising the efforts that have been undertaken so far, the MDBs will concentrate their efforts for next half of the Decade of Action in the following areas:

- ***Encourage an increase in commitment on road safety from politicians, decision makers and civil society involvement.*** There are many stakeholders involved in road safety; the main effort must be directed in encouraging stakeholders to work together between them and with the MDBs to achieve a common goal towards the reduction of traffic fatalities and serious injuries.
- ***Promote capacity building in countries, states/ provinces, and cities.*** Some countries have included road safety in their partnership strategy with MDBs; however, many others still need further encouragement. This encouragement should lead to empower national agencies on road safety, build its capacity, as well as promote the formulation and implementation of road safety national plans.
- ***Promote adoption of corporate road safety plans.*** In order to spread road safety, the promotion of road safety plans for transportation companies (passengers and cargo) exposed to road safety risks are crucial. The ISO 39.001 certification has proved to be effective for the preparation of Road Safety Management Systems. This needs to be accompanied with training and other business-driven initiatives to assure its effectiveness.
- ***Professionalisation of road safety audits.*** Road Safety Audits are only effective if prepared by experienced professionals and followed up by competent staff from the responsible authority. In order to promote proper road safety audit in all transport projects (not only those funded by MDBs), it is necessary to have road safety auditors trained and certified by an independent body. More countries will be ready to develop their own certification procedures for road safety auditors, which can increase national ownership.
- ***Road Infrastructure Safety Management.*** The World Road Association and PIARC released the New Road Safety Manual (World Road Association, 2014) in November 2014, designed to help countries at every stage of infrastructure development to fulfil road safety objectives. In addition, the International Transport Forum also launched its Road Infrastructure Safety Management report (International Transport Forum, 2015). These documents provide guidance on how to identify, remedy and fund low cost solutions on the high risk sections and locations on existing road networks.
- ***Urban road safety plans.*** Fatalities in urban areas are a growing problem, which is linked to the reality that urban plans are very scarce and often do not favour safety. Urban plans of the future must have a balanced approached on safety and mobility.
- ***Promote vulnerable users' safety.*** Vulnerable users (pedestrians, cyclist, and motorcyclist) represent 49% of all road traffic deaths. In low and middle income countries, these users often to come from lower socio-economic background. MDBs overall agenda is to fight poverty and provide equal opportunities to all. Increased promotion of safety for vulnerable road users must be supported by MDBs either through specific actions and/or publications on vulnerable users' safety.
- ***Applied Research.*** Most of the existing road safety research and measures have been undertaken in high income countries that have different situations to low and middle income countries. Interventions for developing countries will need to be adapted in order to be effective. Applied research through demonstration projects, publications and technical assistance needs to be done in order to showcase the advantages of improving road safety. This would help to increase the visibility and mainstream road safety as a major issue in this century.

Conclusions

During the UN Decade of Action for Road Safety, the MDBs have provided support to increase awareness and importance of road safety throughout the world. The year 2015 marked the mid-term of the Decade of Action, which prompted the need to evaluate actions and results obtained, and identify the gaps and actions required to ensure that the goals are achieved by the end of the Decade. MDBs' main achievement in the first half of the decade is the commitment to establish mandatory audits and inspections in transport projects funded by MDBs.

In addition, MDBs have established common guidelines for road safety to ensure better awareness and integration of road safety in MDBs financed projects and program appraisals. These guidelines are part of MDBs' joint effort to share tools and procedures on road safety taking into consideration the different approaches and levels of development in road safety that each MDB manages.

Moving forward, it is necessary to continue mainstreaming road safety in MDBs to ensure its inclusion as an essential component in transport projects financed by the MDBs. The MDBs reaffirm their commitment with governments in supporting capacity building for road safety, the need for certification in road safety audits and increased focus on vulnerable users.

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Making Impacts through the Global Road Safety Facility

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Introduction

The Global Road Safety Facility (GRSF) is a global fund hosted by the World Bank that is designed to build the managerial and operational capacity of low and middle income countries in order to improve efficacy and scale up road safety efforts. Its goals are aligned with the UN Decade of Action 2011-2020, as well as the new UN road safety targets under the Sustainable Development Goals.

Established in 2006, the GRSF provides funding, knowledge, and technical assistance designed to leverage road safety investments in existing or prospective transport and health operations, as well as other sectors relevant to road safety. GRSF's 2015 disbursements are highlighted in Figure 1. The GRSF's partnerships include national governments, state/municipal agencies, the World Bank Group's Global Practices, multi-lateral development banks, international organisations such as the World Health

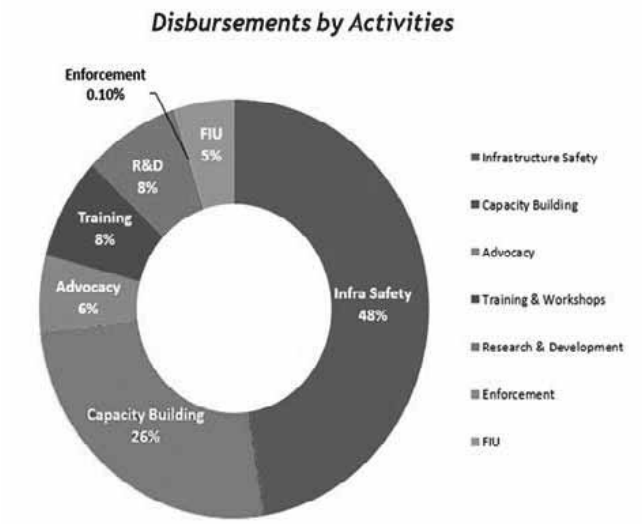

Figure 1. GRSF Disbursement by Activities in Fiscal Year 2015 (FIU = Facility Implementation Unit)

Organization and UN Regional Commissions, NGOs, the private sector, and other key stakeholders (World Bank, 2016).

Key priorities of GRSF are: funding to leverage large sums of road safety investment especially in client countries in which the World Bank is providing assistance for relevant infrastructure: roads or urban projects; and helping clients build the institutional capacity to sustain and improve on road safety solutions over the long-term. GRSF has piloted and supported development and delivery of road safety solutions, in particular with regards to safe road infrastructure engineering and institutional capacity to manage road safety outcomes in client countries.

A key measure of success for GRSF is the extent to which funds donated to GRSF have been deployed to leverage additional funding of road safety. This is achieved by deploying GRSF funds to projects which guide action and improve the commitment to road safety activities. The GRSF has achieved a leveraging ratio averaging over 40 to 1, with some projects delivering leveraging of 80 to 1. That is, on average each dollar donated to GRSF results in over $40 dollars being directly spent on road safety, by the World Bank, Governments and others.

This article briefly highlights some specific success stories of GRSF's effective delivery of road safety solutions, especially regarding the development of national, institutional road safety management capacity and safe road infrastructure engineering.

Supporting road safety management capacity development

Road safety management covers a number of underlying core functions under the UN Decade of Action Plan. In particular, it addresses the aim to "encourage the creation of multi-sectoral partnerships and designation of lead agencies with the capacity to develop and lead the delivery of national road safety strategies, plans and targets, underpinned by the data collection and evidential research to assess countermeasure design and monitor implementation and effectiveness." (WHO, 2011)

One of GRSF's main activities over the past decade has, for example, involved funding country road safety management capacity reviews, which help assess the capacity of a client country to manage road safety, while recommending specific and customised interventions to help the client improve its road safety management capacity, as well as overall road safety in the country. GRSF has supported over 30 such reviews at a country or state/province level.

Developing the Ibero-American Road Safety Observatory

The GRSF played a key role in the establishment and growth of the Ibero-American Road Safety Observatory (OISEVI), which is a regional road safety observatory brought together by international cooperation of the highest road safety authorities across Latin America and the Caribbean. In partnership with the International Traffic Safety Data and Analysis Group (IRTAD) under the OECD's International Transport Forum, the GRSF established a partnership to exchange best practice between IRTAD member countries and data agency counterparts in the developing world. The OISEVI's main objective is to share relevant information about road safety indicators and best practices concerning policy-making, planning and other topics related to road safety. The program links the participating countries to the IRTAD resources on harmonised data collection methods (the "IRTAD-LAC Database").

This process started in 2009, when the World Bank, with assistance and funding from GRSF, financed a stand-alone project in Argentina to provide strategic guidance for strengthening the institutional framework and improving the management of road safety interventions. The project included a key component of US$10 million for developing a road safety monitoring and evaluation system within the Argentinian National Road Safety Agency-National Road Safety Observatory (ANSV). (Bliss & Raffo, 2013)

With support from GRSF and the Spanish government, a pilot training/twinning arrangement was initiated between the ANSV National Observatory and the Spanish Directorate General of Traffic (DGT). The improved capacity for data collection and maintaining a data management system resulted in the inclusion of Argentina in the IRTAD Group.

The Argentina twinning program directly contributed to broader cooperation regarding road safety among the regional countries particularly on important issues like harmonised data collection and sharing mechanisms. Following the 9th and 10th Ibero-American meetings of Heads of Road Safety and Traffic Agencies, 18 countries agreed to create the Ibero-American Road Safety Observatory (OISEVI). Supported by the Global Road Safety Facility, the monitoring program was scaled up to link 22 countries in the region to create the

initial framework and web-based platform. (OISEVI, 2016; Raffo & Bose, 2014). OISEVI continues to gather momentum, with the latest collaborative meeting of the member countries in Cartagena, Colombia in March 2016, also being attended by other countries seeking to join as members.

State and national level capacity development in Brazil

GRSF has funded road safety management capacity reviews across Brazil in the states of Bahia, Rio Grande du Sol, Sao Paulo, and Minais Gerais. State level capacity reviews, along with GRSF and World Bank engagement, have garnered increasing state and federal government interest in road safety. This resulted in GRSF providing Brazil with funding for the largest federal level road safety management capacity review ever undertaken (Job et al 2015). Some of the state level capacity reviews funded by GRSF are leveraging World Bank projects in Brazil, and this recent national level capacity review has a strong chance of leveraging further road safety initiatives in Brazil as well. At the Second Global High-level Conference on Road Safety: "Time for Results," in November 2015 the Government announced action reflecting a number of the key recommendations discussed with the national government in the capacity review, including the harmonisation of vehicle safety standards with Europe.

Argentina Road Safety Project

With GRSF grant and advisory support, the World Bank launched a $38.5 million road safety project in Argentina. The project development objective is to contribute to the reduction of road traffic injuries and fatalities in the borrower's territory through the strengthening of the borrower's institutional framework and management capacity for road safety, and the reduction of road crashes in selected pilot corridors.

The project strongly contributes to the development of a safe system in Argentina and has three main components to work toward this goal, including (World Bank, 2016a):

1. **Institutional Capacity Building:** This component provides support to increase the institutional capacity of ANSV (lead agency), conducts communication, awareness, and education campaigns, improves response capacity in emergencies to improve post-crash care, and strengthens the capacity of traffic control and enforcement.
2. **Demonstration Corridors and Incentive Fund Program:** This component operates a "Safe Corridors" Demonstration Program on 458 kilometres of high risk road network, and works to create an incentive fund for the implementation of road safety policies and practices.
3. **Road Safety Monitoring and Evaluation System within the National Road Safety Observatory:** See the discussion of OISEVI above.

Intermediate project results highlight a number of successful interventions delivering strong outcomes, including: a 35% reduction of road traffic fatalities on the project's pilot corridors; contribution to the national 12% reduction in the road traffic death rate; a national increase of 36% in the seat-belt wearing rate for drivers from 2011 to 2014; and a contribution to an increase in the national motorcycle helmet wearing rate from 39% to 62% in the same period (International Traffic Safety Data and Analysis Group, 2014).

Nigeria Federal Roads Development Project

Over the last several years, GRSF has engaged with the Federal Road Safety Corp. (FRSC), the lead agency for road safety management in Nigeria. In 2008, the World Bank approved the Nigeria Federal Roads Development Project, which initially included a $6 million road safety component. In coordination with FRSC and the project team, GRSF funded a country road safety management capacity review and iRAP survey in 2010. In 2011, the Nigerian government, convinced on the benefits of the road safety component, redesigned and increased the road safety component funding from $6 million to $20 million (World Bank, 2016b). Recommendations from the capacity review and iRAP survey are being implemented in the project.

The newly redesigned and ongoing road safety component includes:

1. **Support to the Federal Road Safety Corps (FRSC):** The main elements of this support include training, capacity building, and vehicle and equipment procurement.
2. **Safe Corridor Demonstration Programs:** Safe corridor demonstrations are being conducted on five high risk roads: This safe corridor approach involves targeted interventions around infrastructure safety improvements, road safety management, enforcement, education and awareness, and emergency services.

Reported success from the project to date include an 11% reduction of road traffic fatalities on project roads (with goal of 25% by project's end); a 30% reduction in road traffic fatalities on the Abujua- Kaduna-Zaria-Kano Corridor from 2010-2013 (project corridor); a 20% decrease in road traffic fatalities in the Abuja Metropolis, despite continued urbanisation and motorisation; and an 8% reduction in road traffic fatalities in Nigeria between 2012 and 2013. (International Traffic Safety Data and Analysis Gropu, 2014).

Karnataka- integrating transport & health through a road safety demonstration corridor

Karnataka presented a unique situation for GRSF, which is helping support two World Bank-funded projects, within the transport and health sectors, collaborating on a multi-sectoral road safety demonstration corridor program. While the transport project is focusing on interventions related to infrastructure, police training and behaviour change programs, the health project is concentrating on building

capacity for emergency care systems and estimating the baseline burden of injuries related to road crashes. An important aspect of the collaboration was to develop a consistent monitoring and evaluation framework to measure the progress on the demonstration corridor for a period of multiple years.

Under the transport project, GRSF helped leverage a $14 million road safety component and employ a safe corridor demonstration program on two high risk corridors. The key highlight of the transport project was the establishment of a multi-sectoral road safety cell, which includes representation from all the key stakeholders. The project also focused on target setting for the infrastructure safety on the demonstration corridor, aiming for a minimum iRAP 3-star rating on the upgraded designs. This target goal exhibits strong commitment from the client.

The health project collected valuable injury data from three districts to serve as the baseline estimates for the demonstration corridor. Funded by the Bloomberg Philanthropies grant, GRSF in collaboration with the Johns Hopkins University (JHU) Injury Research Unit, worked to estimate the burden of road injury and deaths on a Bank-funded project in the state of Karnataka. The road safety component of this project addresses many areas of road safety (World Bank, 2016c).

Development and implementation of road safety infrastructure tools and interventions

Infrastructure is justifiably recognised as a key component contributing to safe road outcomes. A core component of the Decade of Action Plan revolves around safer roads and mobility, in particular how to achieve stronger protection for vulnerable road users utilising road infrastructure assessments and improved planning, design, construction and operations of roads (WHO, 2011). Since its early operational days, GRSF has sought and worked with many partners to help achieve this outcome. This section focuses in particular on one key partnership, iRAP.

Financial and technical collaboration with iRAP

From 2007, the GRSF partnered with the International Road Assessment Programme (iRAP), **a registered charity dedicated to preventing road deaths by** providing tools and training to help automobile associations, governments, funding agencies, research institutes and other non-government organisations in more than 70 countries make roads safe. **Its road safety infrastructure process involves road surveys that help iRAP develop risk maps, star ratings, and safer investment plans so that client countries may implement the appropriate infrastructure engineering solutions to make roads safe for all road users, including vulnerable road users (iRAP, 2016).**

Through funding support from Bloomberg Philanthropies, GRSF has managed the iRAP assessments of more than 40,000 kilometres of high-risk roads in 13 low and middle countries. Subsequent analysis of 14,000 km of the surveyed roads showed the potential to avoid 280,000 deaths and serious injuries over a 20-year period. Just as GRSF has strongly supported the development and global use of iRAP tools, GRSF is also strongly encouraging and incentivising infrastructure solutions based on iRAPs star ratings and safer investment plans, as well as on non-iRAP infrastructure solutions such as road safety audits. For example, with strong engagement through World Bank, India has committed over $240 million to incorporate iRAP recommendations on designs covering 1950 km of highways across several states in India (internal report for the World Bank-iRAP India Phase 1 & 2). In the current Bloomberg Initiative for Global Road Safety 2015-2019 (Bloomberg Philanthropies, 2016), the World Bank is collaborating with iRAP to provide safety inspection of urban streets in 10 cities across LMICs along with increasing sustained capacity for road safety for city officials.

Supporting the development and growth of ChinaRAP

Through both technical and financial assistance, GRSF played a significant role in the establishment and growth of China's Road Assessment Program (ChinaRAP). ChinaRAP is the first country-owned Road Assessment Program (RAP) in the developing world. ChinaRAP has rapidly expanded its operations both nationally within various provinces, as well as by winning international contracts in both developing and developed countries. Currently, ChinaRAP's star ratings and countermeasure plans are being incorporated in 14 different city and highway projects, totalling over US$1.5 billion, in China by the World Bank, Asian Development Bank, and is additionally supporting the Bloomberg Philanthropies sponsored "Road Safety in 10 Countries" initiative. ChinaRAP is also engaging beyond China's national borders. For example, in 2014, the team undertook assessments in Yemen with the World Bank that will help shape a number of projects, such as the Second Rural Access Project (iRAP, 2014).

The GRSF and future operations

This article has focused on two areas in particular regarding GRSF interventions, infrastructure and road safety management. The global road safety agenda is still greatly underfunded. Regardless, as a technical implementing global program, the GRSF will -to the extent its grant financing base allows - work to scale up effective and evidence-based operations globally around road safety by taking a holistic, safe-system, and five-pillar approach to road safety.

An increased focus will likely be placed on areas around improved data collection and analysis, urban road safety, vulnerable road users, digital transport solutions, public-private partnerships, and innovative road safety solutions, through, for example, partnerships with the insurance sector. Low-income countries will also require a great deal more attention given the WHO-reported scale up in fatalities under its last Status Report.

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Management of speed: the low-cost, rapidly implementable effective road safety action to deliver the 2020 road safety targets

by R.F. Soames Job[1] and Chika Sakashita[2]

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Introduction

Delivery of road safety is an urgent global priority, as recognised by key events over recent years. The establishment of the United Nations (UN) Decade of Action for Road Safety and the subsequent development of the UN *Global Plan for the Decade of Action for Road Safety 2011-2020* (UNRSC, 2011) provided global impetus to focus on eliminating the pandemic of deaths and injuries from our roads. This has been followed by the Global Status Report 2015 (WHO, 2015) mid-way through the decade, inclusion of road safety in the Sustainable Development Goals (SDG), and the 2nd Global High-Level Conference on Road Safety hosted by the Government of Brazil and co-sponsored by World Health Organisation (WHO) where the Brasilia Declaration was adopted by 52 ministers/vice ministers to escalate road safety actions towards achieving SDGs.

One of the particularly ambitious SDGs to halve the number of global deaths and injuries from road traffic crashes by 2020 is an enormous challenge - in five years, the annual deaths must drop to approximately 600,000 from well over 1.2 million currently. While ambitious targets assist delivery and the above noted events provide a unique opportunity for road safety, road trauma is vulnerable to the perception that it is uncontrollable and unmanageable. This paper offers a global action to deliver the justifiably ambitious global road safety targets and rationale for the proposed action.

The proposed action to deliver global road safety targets

The proposed action to meet the ambitious global road safety targets is to make speed the global focal point for coordinated action and advocacy. A globally committed focus on speed management allows for a consistent targeted set of priorities and a valid rallying point for advocacy and increased understanding from global and local stakeholders, governments, and the community across different countries, thereby delivering the much needed reductions in deaths and injuries on our roads worldwide. Importantly, this does not imply excluding non-speed related activities. The speed reductions needed to meet the targets can be a motivating bargaining chip in which road safety leaders may manage for less reduction of speed if other actions of established success are undertaken (such as increasing helmet or seatbelt use).

Management of speed is more than management of speeding which is restricted to only addressing those behaviours above the legal speed limit (or in certain jurisdictions defined to also include inappropriate speed for prevailing conditions). However, deaths can still occur without speeding if the speed limit is too high for human bodies to survive the force in the event of a crash. Management of speed therefore also includes setting limits to the speed of travel which are forgiving of inevitable human errors to prevent deaths and injuries in the event of a crash, as well as facilitating compliance with the speed limit.

Rationale for the proposal

Speed is the single element of road safety that, with management, can drive down the number of deaths and serious injuries sufficiently to allow a chance to deliver the global road safety targets within the existing time frames and budgets. This is because speed uniquely has *all* the following features:

1. Speed is the toxic element of road crashes, contributing to both crash occurrence and crash severity;
2. The laws of physics apply in all countries and thus there is no country, state, province, obelisk, or municipality to which the problem of speed does not apply;
3. For management purposes, the benefits of speed reductions on deaths and injuries are well enough quantified by research to allow the prediction of the level of change in travel speed required to deliver the road safety targets;
4. Speed reductions provide strong benefits for all road users including the essential targeting of vulnerable road users (pedestrians, cyclists, motorcyclists), allowing for advocacy by a wide range of NGOs and advocacy groups;
5. A focus on speed management is consistent with the successful Safe System approach to road safety, which is the basis of the *UN Global Plan for the Decade of Action on Road Safety 2011-2020* and many national and state/provincial road safety strategies and action plans;The management of speed entails all the pillars of the road safety management system, allowing for multiple targeted effective actions by all stakeholders;
6. Substantial reductions in speed are possible within the extremely limited budgets likely to be available and within the tight timeframe of the 2020 targets;

7. The capture of the benefits of speed management are possible within the extremely limited budgets likely to be available and within the tight timeframe of the 2020 targets;
8. Reduced speeds will provide synergistic benefits in other arenas of global priority (reducing fossil fuel use, reducing emissions, reducing climate change effects of transport, and reducing noise pollution), which (especially climate change) are capturing political will and funding priority.

These features are considered in turn.

1. Speed is the toxic element of road crashes, contributing to both crash occurrence and crash severity

Speed is the toxin in crashes: damage is caused by impacts of objects traveling at differential speeds (strictly velocities) and via the associated sudden decelerations. The force of impact is proportional to the speed squared, and thus the greater the speed the greater the impact and damage. For instance, a crash at 60km/h has 300% of the energy of a crash at 30km/h. For this reason, even small reductions in speed generate substantial reductions in death and suffering.

Relatively small differences in speed at the beginning of an incident can produce surprisingly large differences in severity of the outcome. For example, based on accepted times for drivers to assess hazards and respond; and known vehicle deceleration rates under braking; one driver traveling at 100km/h versus another driver traveling at 110km/h can end with the first driver braking in time and having no crash versus the second driver with the same judgment, reaction times, and braking as the first driver still traveling at over 55km/h, where the first driver stopped, and most likely having a fatal or very serious crash. Thus, a 10km/h difference at the start can result in a 55+km/h difference at the end.

Not only does speed increase crash severity through increased impact and energy, but it can also cause crashes. Speed can contribute to occurrence of crashes by reducing the capacity to stop in time; reducing manoeuvrability in evading a problem; making it impossible to negotiate curves and corners at speeds above those which simple physics will allow for the friction available; and causing others to misjudge gaps. For example, a vehicle travelling above the speed limit allows pedestrians less gap to cross the road than expected.

The toxic effect of speed is demonstrated by an extensive analysis of many studies over many countries showing a strong increasing relationship between average speed and the risk of injury and of death (Nilsson, 2004). Sound evidence also exists to show that driving at 5km/h above the limit in an urban environment is equal in risk of death and injury to driving at the blood alcohol concentration of .05 (Kloeden CN, McLean AJ, Glonek G, 2002). A summary synthesis of many studies in various states of the USA also shows large increases in crashes and deaths with speed limit increases across many states of the USA (Stuster, J Coffman, Z & Warren, D 1998). By definition of crashes speed contributes to 100% of road deaths and serious injuries.

2. The laws of physics apply in all countries and thus there is no country, state, province, obelisk, or municipality to which the problem of speed does not apply

Speed is not a unique problem for specific countries, or specific regions but a common problem that applies to all parts of the world. While much of the evidence comes from high income countries because good crash and other data are often not available in low and middle income countries, the evidence for the toxic effect of speed and benefits from speed reductions applies to all countries and regions due to the ubiquitous laws of physics.

3. **For management purposes, the benefits of speed reductions on deaths and injuries are well enough quantified by research to allow the prediction of the level of change in travel speed required to deliver the road safety targets**

Ample evidence exists for the benefits of speed reductions via speed enforcement on deaths and injuries (WHO, 2008; OECD, 2006, Wilson C, Willis C, Hendrikz JK, Le Brocque R, Bellamy N., 2010). Studies have also shown the benefits of different forms of speed enforcement including fixed cameras, mobile cameras, and point-to-point or average speed cameras (Goldenbeld, C., van Schagen, I., 2005, Cameron, MH, Cavallo, A & Gilbert, A. 1992, Job 2012, Keall, MD., Povey, LJ. & Frith, WJ., 2001, Gains A, Heydecker B, Shrewsbury J, Robertson S., 2004). Independent evaluation of fixed speed cameras in the state of New South Wales (NSW) in Australia revealed that at treated locations, the cameras resulted in a 71% reduction in speeding and an 89% reduction in fatalities (Job, 2011). Because speed cameras only address speeding as a crash factor, clearly these results suggest that speeding was contributing to most fatalities. This is in contrast to the official estimates (based on Police reports) indicating that speeding contributed to around 35% to 40% of fatal crashes in NSW. Often the real extent of contribution of speed is significantly underestimated in most police statistics, because in many crashes where speed was a factor this is not apparent after the crash has occurred. Thus benefits of reduced speeds can be larger than expected based on data on speeding (traveling above the speed limit) only. What is clear is that real benefits of speed reductions on deaths and injuries exist and, though underestimated, they are quantifiable.

Direct evidence for the benefits of reducing speed limits on deaths and serious injuries also exists. A before and after evaluation study of a speed limit reduction from 110km/h to 100km/h on a rural highway in NSW showed a 26.7% reduction in casualty crashes (Bhatnagar Y., Saffron D., de Roos M. and Graham A., 2010). Similarly in the state of South Australia reduction in speed limit from 110km/h to 100km/h showed benefits of crash and injury reductions by around 27% compared to roads which remained 110km/h (Mackenzie, J.R.R., Kloeden, C.N., Hutchinson T.P., 2014). In the state of Victoria casualty crash rate increased by 25% when the speed limit was increased from 100km/h to 110km/h and decreased by almost 20% when the speed limit was decreased back to 100km/h (Sliogeris J., 1992).

Speed enforcement tolerances create *de facto* speed limits which allow speeds that are more dangerous than the intended speed limit, and often result in travel speeds which are simply too high for safety and even for the road design by which the speed limit was determined (without consideration of the *de facto* limit). Drivers learn (sometimes incorrect) tolerances through rumour, media, and knowledge of tickets issued, even if the tolerance is not officially disclosed. States and countries are typically reluctant to reveal enforcement tolerances and thus studies of the effects of reduced tolerances are rarely published. An exception is the analysis presented in the Victoria Auditor General report, which provides an assessment of the impact of changes in speed camera policies in Victoria including the lower enforcement tolerance, though the tolerance used by Police is deliberately not disclosed. The greatest benefits of reduced travel speeds from lowered speed enforcement tolerances were shown in Melbourne's 40km/h, 50km/h and 60 km/h zones (where enforcement is common) - fatalities decreased by around 40% from over 100 per year for 1999-2001 to 64 in 2005, and serious injuries by around 7% from 6,379 in 2004 to 5,916 in 2005 (Auditor General Victoria, 2006).

The predictable benefits of speed reductions identified above is key for management and action as the predictability allows the identification of intermediate target speed reductions required to deliver the global road safety targets and therefore better action plans. As above, the strong increasing relationship between average speed and the risk of injury and of death provide quantifiable substantial benefits (Nilsson, 2004). From Nilsson's synthesis we can estimate what speed reduction is required to achieve target reduction in deaths. (Alternatively, in some locations a lesser reduction in mean speed accompanied by the right increase in helmet wearing or median separation of the road may also deliver the same saving of lives, suffering and economic costs).

4. **Speed reductions provide strong benefits for all road users including the essential targeting of vulnerable road users (pedestrians, cyclists, motorcyclists), allowing for advocacy by a wide range of NGOs and advocacy groups**

The strong relationship between speed and the risk of injury and of death applies to all road users involved in crashes. Speeds of impact create large differences in survivability for all road users, with death likely at much lower speeds for vulnerable road users. A large scale evaluation study of 820 locations where speed limits were reduced to 40km/h at school zones in NSW showed impressive reductions in crashes for all road users not just school aged pedestrians—pedestrian casualties aged 5 to 16 decreased by 46% while all pedestrian casualties decreased by 45% (Graham A., & Sparkes P., 2010). Speed management is thus an inclusive solution for all road users globally. This allows for advocacy by a wide range of NGOs and advocacy groups.

5. A focus on speed management is consistent with the successful Safe System approach to road safety, which is the basis of the *UN Global Plan for the Decade of Action on Road Safety 2011-2020* and many national and state/provincial road safety strategies and action plans

The Safe System approach has been successful in multiple jurisdictions (Mooren, L, Grzebieta, R., Job, R.F.S. Williamson, A. 2011), and is the basis of the UN *Global Plan for the Decade of Action on Road Safety* and multiple national and other level strategies and action plans (Australia and many of its states, Ireland, New Zealand, Poland, Qatar, and many others). It is based on the assumptions that humans will inevitably make mistakes and thus road safety will not be achieved by fixing the human. Rather we must work from the known limits of the human body to survive forces and ensure that we provide a transport system in which humans, in spite of their errors, are not exposed to forces beyond those which we can survive.

The management of speed is directly consistent with Safe System approach - forces can be reduced to survivable levels by reducing speeds of travel and thus impact forces (though of, course, many other road safety activities work this way). Thus management of speed is in line with strategies and action plans in many different countries worldwide.

6. **The management of speed entails all the pillars of the road safety management system, allowing for multiple targeted effective actions by all stakeholders**

The management of speed entails actions from all the transport pillars of the road safety management system: safe road and roadsides; safe vehicles; safe road users. Post-crash care is the exception, though supporting advocacy from this highly credible sector can be expected. This allows for all sectors of road safety to play a role in delivery of global road safety targets.

Road and roadside infrastructure are critical elements of the system in the management of speed. Speed reduction via road and roadside infrastructure is especially applicable to pedestrian crashes as well as crashes more generally (WHO, 2013). Examples include well-designed roundabouts; the narrowing of apparent lane width through use of lane lines; rumble strips; speed humps and speed cushions though only for around 120m (Huang, J., Liu, P., Zhang, X., Wan, J., and Li, Z., 2011); chicanes or pinch points. Critically, many of the road engineering treatment options (e.g. speed humps and lane marking) are relatively inexpensive and can be implemented quickly.

Speed governing vehicles can assist with management of speeding, and the technology exists to achieve this cheaply. Intelligent speed adaptation can be inexpensive if introduced on mass, and the evidence shows clear benefits even for warning (advisory systems) but much larger benefits for direct speed limiting systems (Carsten OMJ**,** Fowkes M, Lai F, Chorlton K, Jamson S, Tate FN, Simpkin R, 2008). However, the lead time for substantial safety benefits from vehicle safety features is significant.

Use of legislation to reduce travel speed via appropriate speed limit setting and to reduce speeding are necessary for effective enforcement and norm setting. Experience in NSW shows benefits of targeting high risk groups with higher penalties for speeding. Following research showing over-representation of young drivers in serious speeding

crashes (Sakashita C, Graham A, de Roos M, Croft S, Elliot M., 2007) changes to novice driver license conditions were made including that any speeding offence by a Provision 1 licence holder would result in loss of licence for three months in addition to other penalties. This produced an immediate 34% reduction in speeding fatalities involving Provisional 1 drivers (Job, 2013), demonstrating that the large role of speeding in young driver serious crashes can be managed by effective enforcement and penalties.

Education and promotion also play important roles in speed management. There is value in explaining to the community why the change in speeds is being made and promoting the changes before they are enforced. First, people are more accepting of the change if they feel that they were informed rather than it was unfair, and political will can be sustained. Second, compliance is greater if people change their behaviour before any enforcement takes effect rather than waiting on enforcement. Nonetheless, once the education and warning of change processes have occurred enforcement is an important follow-up activity to increase compliance of drivers/riders who continue to deliberately exceed speed limits.

Speed enforcement, especially a mix of covert and overt enforcement rather than overt alone (Keall, MD., Povey, LJ. & Frith, WJ., 2001), is a crucial element of speed management. Speed camera programs can be utilised to deliver more enforcement in priority locations in terms of death and injury risk. Although there is the possibility of a contribution from a regression to mean effect following an increase in deaths in 2011 in Poland, a revamped speed camera program in 2012 along with extensive publicity has been attributed for the reduction in deaths by almost 15% from 4189 in 2011 to 3,571 in 2012 (Czapski R., Job, RFS, McMahon, K. Giemza, J., 2013; IRTAD, 2013). Speed enforcement tolerance must also be appropriately managed because a small tolerance is seen as socially necessary to allow the view that enforcement is fair. The key issue to be resolved is the setting of a tolerance which facilitates safety as far as possible rather than creates a *de facto* higher speed limit yet allows some margin for error and social acceptability.

7. **Substantial reductions in speed are possible within the extremely limited budgets likely to be available and within the tight timeframe of the 2020 targets**

In order to achieve the ambitious SDG to halve the number of global deaths and injuries from road traffic crashes by 2020, extremely cost-effective interventions which will deliver the required large reductions with the limited resources likely to be available must be considered and adopted. As identified above, speed reductions bring about large reductions in deaths and injuries, and relatively low cost speed reduction interventions are readily available. Speed humps are cheaper and faster than many other treatments and take minimal maintenance; speed limits signs can be changed cheaply (though the total cost will add up); and speed cameras commonly raise more money than they cost.

Less than five years remain before 2020 when the target to halve the number of global deaths and injuries from road traffic crashes is due. Interventions which can be quickly implemented and which can quickly deliver large gains are therefore essential. The processes of changing speed limit signs or increasing enforcement are much faster than most other areas of change in road safety, which also have the capacity to deliver large gains but are unlikely to deliver most of the gains within the timeframe remaining. For example, assessments and engineering treatments take time to roll out; while vehicle safety improvements are faster than they were, the vehicle fleet changeover in low and middle income countries is slow, and the newest vehicles tend not to start in the hands of those who need them the most— young and novice drivers who cannot generally afford a safe new car; coordination and capture of benefits of school education programs also tend to take time. These types of interventions accrue their benefits over a longer-term than interventions such as changing speed limit signs, reducing enforcement tolerances, and increasing enforcement or penalties.

8. **The capture of the benefits of speed management are possible within the extremely limited budgets likely to be available and within the tight timeframe of the 2020 targets**

Speeds are readily and rather cheaply measurable compared with other baseline performance measures for road safety. Speeds measures can be collected automatically and inexpensively with simple robust technology which allows for continuous data collection over days or weeks, with minimal effort. Such technology is readily available and in common use now in many countries. This affords effective objective baseline setting, monitoring of progress towards the target speeds, and demonstrating the benefits of speed management interventions.

9. **Reduced speeds will provide synergistic benefits in other arenas of global priority (reducing fossil fuel use, reducing emissions, reducing climate change effects of transport, and reducing noise pollution), which (especially climate change) are capturing political will and funding priority**

At the Paris climate conference (COP21) in December 2015, the climate change agenda (rightly) achieved a strong mandate for action which will absorb and attract considerable resources. Aligning road safety activity to this agenda and other agenda such as fossil fuel consumption, air pollution and noise pollution through identified synergies may increase support. Open road travel time increases are generally smaller than expected with speed limit reductions and economic gains can follow reduced speeds due to the reduced costs of crashes, fuel use, and road maintenance (Cameron, M., 2003). The economically ideal speed for trucks is lower than the 100 km/h or higher speed limits on many motorways, though this varies slightly with fuel costs and other factors (Cameron, M., 2003). Reduced open road speeds also reduce noise and air pollution, and emissions and thus negative impacts of transport on climate change, life quality and health (Job, RFS. 1996; WHO Regional Office for Europe, 2012).

Reducing urban speeds on arterial roads especially also creates synergistic benefits with these other agenda, due to reduced fuel consumption and reduced congestion.

Counter-intuitively, traffic is not simply congested by reduced speeds. Maximum traffic flow is achieved at 50km/h compared to 70km/h and above (OECD 2006). The OECD report, based on analysis of thousands of real world locations, shows that the number of vehicles passing through a given point decreases for speeds of 70km/h and above compared with 50km/h. In addition, congestion arises because there are too many cars for the road space and in this circumstance the speed limit becomes irrelevant.

Challenges for the proposed action and how to address them

The extensive evidence cited above shows that speed reductions clearly deliver road safety gains. However, some speed reduction interventions are not popular (though many are sought or directly implemented by the community: see Figure 1) and challenges in implementation will exist, including persuading governments and communities of the value of this approach. While a minority of people may make misinformed claims regarding speed limit reductions, speed enforcement, and speed management, sound arguments to address such views are also available (Job, RFS., Sakashita, S., Mooren, L., Grzebieta, R., 2013; Mooren, L. Grzebieta, R. & Job, S., 2013). It is worthwhile to anticipate a few common ill-informed arguments and address them:

1. Lower speed limits do not work for road safety because they increase travel times and thus increase fatigue;

2. Lower speed limits do not work for road safety because drivers spend more time watching their speedo instead of the road;

3. Lower speed limits are just for revenue raising.

All three claims are clearly erroneous as shown by the many scientific evaluations which show overall benefits of reduced speed limits (see brief review above). The first two are theoretical claims whereas the evidence for benefits of speed reduction is entirely practical based on real world outcomes of reduced speed limits. The practical evidence includes any supposed dis-benefits of the first two hypothetical concerns, yet resoundingly shows safety benefits of speed limit reductions.

If drivers are unable to manage both the scanning of their environment for safety and the monitoring of their speed, then perhaps they should reconsider their ability to drive safely or slow down to a point where they are capable of conducting both these required processes. Most modern cars offer warning systems of speed limits which can be applied to assist the driver know if they are above the prevailing speed limit.

The third claim is important to consider even if dismissed by the evidence for the safety value of reduced speed limits. It is true that speed enforcement collects revenue, but this is after all a voluntary tax which can be avoided entirely by sticking to the speed limit. The collection of revenue by speed enforcement is analogous to the scar created by life-saving surgery: the scar and the revenue are the most visible outward signs though the surgery and the enforcement serve greater purposes.

Figure 1: A rope placed across the road acts as an effective speed hump in a local residential street (Photo by Job RFS)

Conclusion

The presently proposed strategy to deliver the justifiably ambitious road safety targets is to make speed the focal point for coordinated action and advocacy, but not to exclude non-speed related activities. The approach may be presented as options: speed limit reductions to a certain required level; or lesser speed limit reductions if combined with other interventions with known benefits. The presentation of the approach with such realistic options provides choices and may incentivise addition of alternative actions in order to adopt lesser speed reductions. However, we need to manage a risk that optimistic assumptions about the benefits of alternative activities may limit net road safety gains. A globally committed focus on speed reductions is particularly attractive because of its low-cost, rapidly implementable nature, allowing a chance to deliver the required large reductions in deaths with the limited budget and time available. While some speed management interventions may be politically challenging to introduce, effective communications will be of significant assistance and there is no better time to strengthen speed management actions than now with the globally heightened agenda for road safety.

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Conference Gala Dinner & Award Ceremony

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- **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.

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