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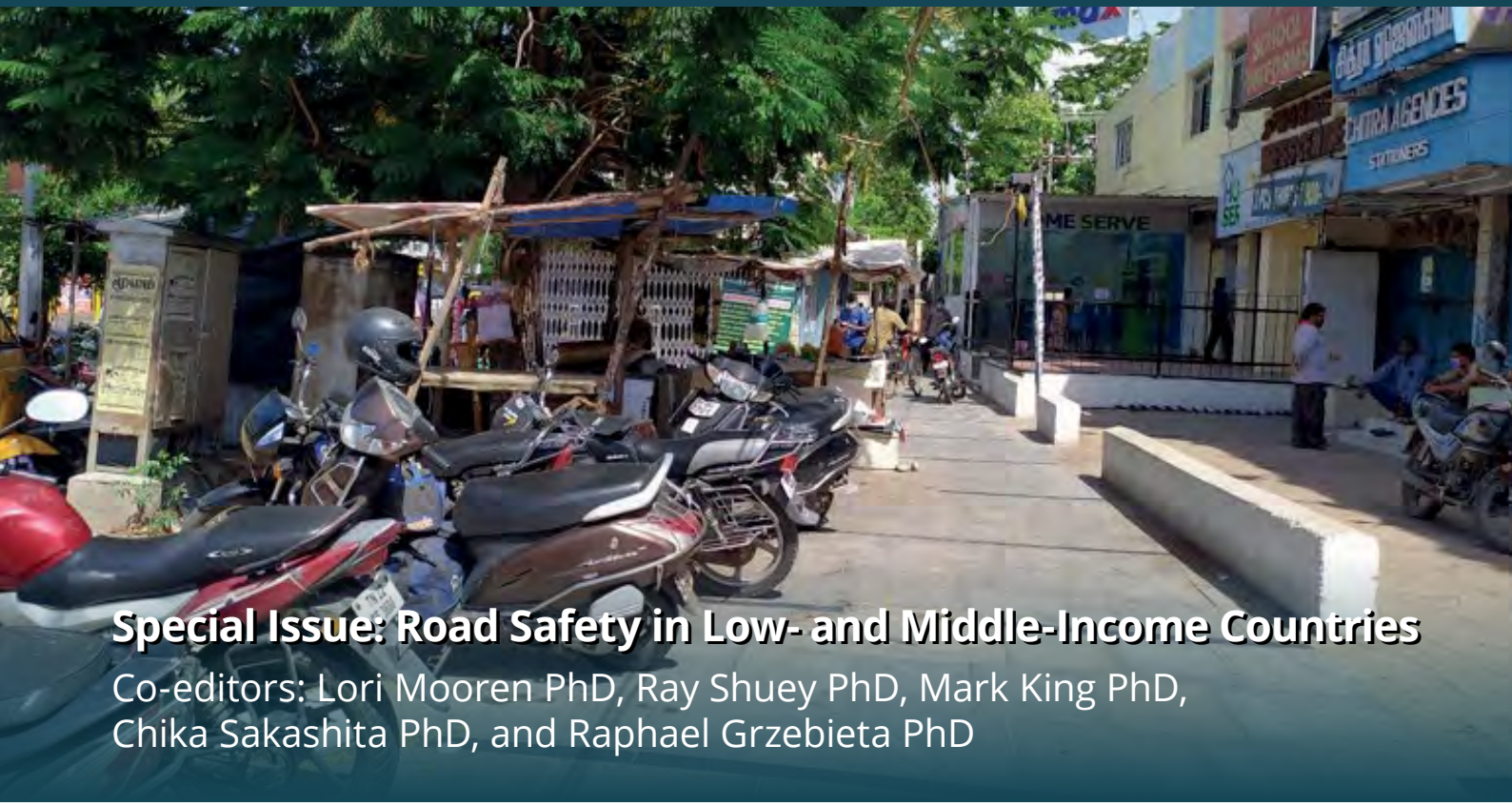
Journal of Road Safety



Special Issue: Road Safety in Low- and Middle-Income Countries

Co-editors: Lori Mooren PhD, Ray Shuey PhD, Mark King PhD, Chika Sakashita PhD, and Raphael Grzebieta PhD

Near miss or tragedy - the difference is speed

Speed also reduces the time you have to react to a mistake, yours or someone else's

We want everyone who uses our roads to get home safely.

To prevent people from being killed or seriously injured on our roads, we can set speed limits that are safe and appropriate to the level of risk on the road.

A small change in speed can make a big difference.

This is part of the government's Safe Network Programme to make our highest risk roads safer.

nzta.govt.nz/safety

WAKA KOTAHI NZ TRANSPORT AGENCY / ROAD TO ZERO

New Zealand Government

NSW speed zoning data has gone open data

Transport for NSW has released open speed zoning data on the NSW Open Data Hub.

This enables researchers, policy makers, app developers, road safety partners and other interested groups to access the speed limit and speed zoning data on NSW roads.

The information assists in making NSW roads safer by providing speed zoning data to customers where and when it is important and relevant to their journey.

Since the Open Data Hub launched in 2016, speed zone data has been one of the most requested datasets from developers and researchers. Speed zone data was also ranked in the top five datasets our community wanted to see in the open data 2017 survey.

By making speed zone data accessible on the Open Data Hub, innovators and entrepreneurs are empowered to find new ways to use the data to promote safety on NSW roads.

To view the dataset and resources, visit the Open Data website: **https://opendata.transport.nsw.gov.au/dataset/speed-zones**

This dataset contains data for NSW speed zones that are categorised as:

- Ordinary permanent
- Shared
- High pedestrian
- School
- Variable
- Local traffic
- Truck & bus
- Wet weather
- School bus
- Toll plaza
- Default.

NSW GOVERNMENT | TOWARDS ZERO

open data

Introducing Road Safety Victoria and the Department of Transport

The Department of Transport (DoT) brings together all transport modes to design, plan, deliver and operate Victoria's transport system. We're focused on outcomes that deliver more choice, connections and confidence in our travel, ensuring the whole transport network works as one to deliver better services.

DoT's vision is to meet the aspirations of Victorians and businesses for a transport system that is simple, connected, accessible, reliable, safe and supports a productive, growing economy.

Victoria has a proud history of road safety innovation and within the Department, Road Safety Victoria (RSV) has recently been established to provide a dedicated office to improving safety for all Victorian road users.

RSV works closely with road safety partners – Transport Accident Commission, Victoria Police, the Department of Justice and Community Safety, and the Department of Health and Human Services – to deliver strategic and coordinated road safety policies, programs and initiatives.

Find out more at **transport.vic.gov.au**

VICTORIA State Government | Department of Transport

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Cover image

The photo shows Luz Church Road in Mylapore, Chennai, an important commercial area in the centre of the city. This stretch of road was redesigned several years ago to make it more pedestrian-friendly. However, in no time the footpaths were encroached upon by shops, small vendors, a temple, and parked vehicles. See the Original Road Safety Research article: Narayanan, S. (2020). "Pedestrian Safety in Chennai". *Journal of Road Safety*, 31(3), 15-32. Photo: Sumana Narayanan, CAG.

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Editorial Policy
The *Journal of Road Safety (JRS)* is an international, scholarly, cross-disciplinary, peer-reviewed and open-access journal purely focused on road safety. The JRS accepts papers from any country or region and aims to publish a diverse range of high quality papers on road safety from researchers, policy makers and other road safety experts.

All papers submitted to the JRS undergo a peer-review process, unless the paper is submitted as a Contributed Article or *Correspondence (Letter to the Editor)*. Peer-review Papers and Contributed Articles can take the form of the following articles types: *Original Road Safety Research; Road Safety Data & Research Methods; Road Safety Policy & Practice; Road Safety Case Studies; Road Safety Evidence Review; Road Safety Media Review; Perspective on Road Safety*.

All submissions are assessed on the basis of quality and importance for advancing road safety, and decisions on the publication of the paper are based on the value of the contribution the paper makes in road safety. Once a paper is submitted, the Editor-in-Chief and/or Managing Editor initially review the submission. Authors are notified if their paper is judged to be outside of the JRS' scope or lacks originality or message that is important to the readers of the JRS.

Peer-review submissions that pass the initial screening process will be sent out to a minimum of three peer reviewers selected on the basis of expertise and prior work in the area. Additional peer reviewers may be called on at the discretion of the Editor(s), e.g. in the case of a disagreement between referees' opinions. The names of the reviewers are not disclosed to the authors. Each submission is peer-reviewed by a minimum of three experts in the field.

Based on the recommendations from the peer-reviewers, the Editor-in-Chief makes a decision, in consultation with the Managing Editor and/or Editorial Board when needed, to accept or reject a manuscript, or to request revisions from the author/s in response to the comments from the reviewer/s. Authors are informed of the decision after the first round of review. Revised submissions are sent out for a second round of review and authors are again notified of the decision based on the recommendations from the peer-reviewers.

Contributed Article submissions that pass the initial screening process will be reviewed in detail by the Managing Editor and an additional reviewer may be called on at the discretion of the Editor(s) or the paper may be subject to peer-review, e.g. in the case of contentious contents that need expert assessment. The Managing Editor makes a decision, in consultation with the Editor-in-Chief and/or Editorial Board when needed, to accept or reject a manuscript, or to request revisions from the author/s in response to the comments from the reviewer/s. The names of the reviewers are not disclosed to the authors. Authors are informed of the decision after the first round of review.

As a rule of thumb, manuscripts can undergo only one major revision. Any editorial decisions regarding manuscript acceptance by the Editor-in-Chief and Managing Editor are final and further discussions or communications will not be entered into in the case of a submission being rejected. For both peer-review and contributed articles, one or more of the reviewers may require a major revision or reject the paper because of content that may otherwise be of general interest to readers but is not at the level expected of a caliber of a scientific journal paper.

Author responsibility
Authors are responsible for complying with all the requirements (including Article formatting, References, Ethics in publishing, Originality & plagiarism, Author declaration) before submitting their papers. Authors must write entirely original works, and appropriately cite the work and/or words of others to ensure originality and avoidance of plagiarism. Authors of original road safety research articles should present an accurate account of the work performed as well as objective discussion of the findings and their significance. Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint), that it is not under consideration for publication elsewhere, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder.

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Editorial Board

From the President

At a time when the Australasian College of Road Safety is establishing an International Outreach Chapter, this Special Issue on Road Safety in low- and middle-income countries (LMICs) of our long running journal is very special.

Particular thanks go to the co-editors of this Special Issue – Dr Lori Mooren, Dr Ray Shuey, Dr Mark King, Dr Chika Sakashita and Professor Raphael Grzebieta. They reflect the College at our best. Committed to the long haul, to learning and development and to road traffic safety as a development issue – they have professional networks that span the continents and support new people coming through.

This Special Issue of the *Journal of Road Safety* demonstrates the capacity of the College and our membership to engage and influence others. The geographical and topic spread in this Special Issue is extraordinary – each contribution vitally important in its own right. It has given me particular cause to reflect on several levels.

Personally, I have for seven years now recognised the extraordinary privilege to be invited into many LMICs across Asia and Africa to provide advice to governments about how to tackle their road safety problem. I deliver as well as I can, but the future of road safety is not white middle-aged male anglophones like me. It is the Indian public servant – she took a one-hour conversation with me and built a lead agency unit for her State in the course of a year. It is the Ethiopian engineer – he took the strategy we prepared and is making safety blossom in his city. They and the people they work with are the future of road safety and we must support them as much as we can. They are essential if we are to realise our vision of elimination by 2050.

Professionally, I have found myself thinking about the new energy which has come in globally from very different perspectives – the man who cut his advocacy teeth fighting

big tobacco in Eastern Europe, the woman who took her urban development background to improve safe mobility in Mexico. Not everyone who comes into road safety stays, but it is clear to me that one of the big benefits of the Bloomberg Initiative for Global Road Safety is that it has supported the entry of a much stronger health and environmental agenda into the road safety profession. These professional voices and actors are bringing new life to safety in poorer countries where, quite frankly, the transport professions from richer countries have left a deadly legacy of victim blaming.

Politically, I have found myself wondering where the decision rights for safety lie at a global level, and why I never highlight the high proportion of trauma to men and boys. My work in Africa has been particularly enlightening, and leaves me convinced of the need for the regional institutions of Africa, Asia and the Americas to be in the middle of any decision making on the global road safety agenda. As for gender, women and girls may not be the ones being killed and maimed, but they are inevitably the ones who are picking up the pieces in families and carrying the burden in communities as a result of road trauma. Just like women and girls do in every major development issue.

The 3rd Global Ministerial Conference on Road Safety in Stockholm earlier this year was at its strongest in considering road safety within the global sustainable development agenda. This is not an agenda for somewhere else, where more people are being killed and maimed, or the casualty rates are higher. It is an agenda for Australia and New Zealand. We would have significantly better road safety records now if we had followed the advice which is routinely endorsed by the world's multilateral institutions. The coming decade will require us in part to go back to some basics of what is required to eliminate the scourge of road trauma.

As our College steps out into the world, we must do so with knowledge and humility, neither better nor worse. Our societies are different, but some of our core safety problems are achingly similar. I hope you learn as much from this Special Issue as I have.

Martin Small
ACRS President

From the CEO

The ACRS International Outreach Chapter – Sharing our exciting plans!

For my message to members in this Special Issue on Road Safety in Low- and Middle-Income Countries (LMICs), I would like to share some exciting news. I would firstly like to acknowledge all team members and co-authors involved with me in progressing this work: Mr Eric Chalmers AM (ACRS), Dr Mark King (CARRS-Q), Mr Martin Small (ACRS), Dr Chika Sakashita (ACRS) & Mrs Anna Lang (ACRS).

Australian Government

Department of Infrastructure, Transport, Regional Development and Communications

The College is delighted to be strengthening our outreach work to LMIC's via an International Outreach Chapter. This is due to the generous support of the Federal Australian Government through the Road Safety Awareness and Enablers Fund, together with the support of our Committees, Members and broader stakeholder groups both regionally and globally.

Why this LMIC Outreach?

The purpose of the College is to support our members in their efforts to eliminate serious road trauma through knowledge sharing, professional development, networking and advocacy. Now into our fourth decade, we continue to demonstrate the value of a road safety professional body and want to explore the opportunity for like-minded professional bodies to be established where they are needed most.

Estimates by the World Health Organization suggest that road crashes kill 1.25 Million people each year — nearly 3,400 road fatalities per day — and injure up to 50 Million. Traffic injuries are not equally spread over the world. Some countries are hit harder than others, and the chance of being killed in a road crash depends on where one lives. 93% of all traffic casualties occur in LMICs. Globally, the number of fatalities per 100,000 population (mortality rate) ranges from less than 3 to over 30. The rate in high-income countries is 9.3, middle-income countries 19.2, and low-income countries 27.5 (WHO 2018).

Federal government support critical

In partnership with the College, the Australian Government continues to be a committed supporter of road trauma reductions in LMICs. This ongoing commitment includes being an active Corporate Member of the College, providing input to programming (and participation at) events and activities such as the annual Australasian Road Safety Conferences, provision of funding support for the LMIC Scholarship Program, and ongoing support for the College's *Journal of Road Safety (JRS)*.

Over the last 4 years the Australian Government has supported the participation of 22 LMIC scholarship awardees at our conferences – ARSC2016 through ARSC2019. These delegates have come from 11 LMIC countries – Cambodia, Malaysia, Indonesia, Vietnam, Philippines, Laos, India, Nepal, Iran, Pakistan and Bangladesh.

Scholarship awardees have highlighted the following benefits in particular:

- An opportunity to build up networks through the international platform of the conference;
- Strengthening existing connections to important stakeholders and programs, such as the *Journal of Road Safety*;

Above: Recent LMIC Scholarship Winners

Dr Lori Mooren, Dr Mark King, Dr Ray Shuey, The Hon Michael McCormack MP Deputy PM, Dr Srivanas Puppala (India), Dep Director Sangkhom Phommarath (Lao PDR), Colonel Visal They (Cambodia)

- The Conferences broad range of attendees including academia and practitioners, has enabled future work to be facilities through organisations such as Austrade and enforcement agencies.
- In practical terms, the scholarships have facilitated material benefits such as the donation of 130 radar and laser speed guns from Victoria Police to Lao PDR;
- Follow-up training in speed management, and direct assistance of capacity building for traffic enforcement operations have also been achieved as a result of the scholarships.

Through the Australian Government's relatively new Road Safety Awareness and Enablers Fund (RSAEF), the College is in the process of setting up an International Outreach Chapter to sit alongside our existing Chapters in Australia and New Zealand.

Above: Recent LMIC Scholarship Winners:

Colonel Visal They (Cambodia), Dr Srivinas Puppala (India), Deputy Director Sangkhom Phommarath (Lao PDR)

The RSAEF supports road safety enablers such as the College to deliver safe system initiatives that focus on:

- Road safety awareness;
- Road safety education; and
- Road safety collaborative activities at a local, national and international level.

The College is proud to be contributing to all of these outcomes, in partnership with the Australian Government, through delivery of the International Outreach Project. This project will complement all existing outreach collaborations such as those outlined above.

What the College Aims to Achieve

The International Outreach Project extends the support provided by ACRS and the Australian Government. The College has existing strong links to LMICs though our individual members and member organisations, and the Australian Government through a variety of programs operating in the region. These linkages are being strengthened in several ways. We have seen consistent attendance of conference delegates from LMIC's, and the Australian Government has committed to supporting the scholarship program over four years. We also have an increasing number of LMIC authors publishing in our internationally recognised peer-reviewed *Journal of Road Safety*, and have initiated a mentoring program to help further increase this.

The International Outreach Chapter is intended to extend the benefits of our College membership to road safety practitioners in LMICs, and to form a platform from which other professional bodies may go on to be independently established. Over time, we would be delighted if the Australasian College of Road Safety became a member of an International College of Road Safety. For now, we are focused on utilising:

- Existing strong links in Asia and the international road safety community;
- Existing strong Chapter structure and linkages across Australasia;
- The *Journal of Road Safety* mentoring programs, and Special Issue such as this one;
- Online activities including newsletters, websites, webinars and videoconferencing technologies; and
- The Australasian Road Safety Conference program.

Given our proximity and our existing links, the project aims to spread this capacity to Asia in the first instance. When successful we can support other regions in the future.

The new International Outreach Chapter aims to bring all stakeholders together in an independent space located in one or more countries. As is successfully shown in our existing Chapters, this activity supports integration and collaboration in developing effective solutions. We have proven the value of this approach in Australasia and this project provides an opportunity to share our successes and experience with our Asian colleagues.

We look forward to keeping you informed as this project progresses – watch this space!

As always, stay safe, and best wishes,

Claire Howe
Chief Executive Officer - ACRS

ACRS Chapter reports

Chapter reports were sought from all Chapter Representatives. We greatly appreciate the reports we received from ACT and SA.

Australian Capital Territory (ACT) and Region

2020 AGM

The ACT & Region Chapter held its Annual General Meeting on 11 June 2020. The following members were elected to the Executive Committee:

Chairperson & National Delegate	Eric Chalmers
Deputy Chairperson	Joanne Ridley-Wilson
Treasurer	Steven Lake
Secretary	Keith Wheatley

The meeting also agreed on a work program for the next year, recognising some flexibility may be required in view of the difficulties arising from the current pandemic situation:

- Continue the Wildlife project through the recently formed Working Group;
- Undertake discussions with National Office of Road Safety to encourage active involvement in the Chapter;
- Conduct a Forum or Webinar with COTA ACT on safe driving for older drivers;
- Conduct a Forum with the ACT Road Safety Unit of the Justice and Community Safety Directorate in late 2020 or early 2021;
- The Chapter and National Office will again establish an information centre at the next Governor General's Community Open Day (date to be set depending on Covid 19 requirements).

CURRENT PROJECTS

Wildlife Project

The Chapter has continued to progress with other stakeholders its investigations into the extent and seriousness of crashes involving road users and wildlife primarily in the ACT and region but also making provision for extending enquiries into other jurisdictions.

Working group meetings have been held this year, a project strategy developed, and specific tasks are being undertaken to progress the project. It had been intended to broaden the discussions with interested parties in other jurisdictions at the now postponed 2020 Australasian Road Safety Conference. However, the Working Group will assess how this may be best achieved – perhaps having to wait until the 2021 Conference.

Older Drivers

The Chapter and the Council of the Ageing (COTA) are actively considering alternatives for the delivery of road safety advice for older drivers. They will depend on Covid19 meeting requirements and preferred ways to interact with older road users in the community. Chapter members in NSW recently developed and presented a webinar for older drivers in the Goulburn and Eurobodalla areas that was s very successful. A similar presentation for the ACT will be considered.

ACT Chapter Chair and Secretary
Mr Eric Chalmers & Mr Keith Wheatley

South Australia (SA)

Lunchtime Webinar: Friday 12 June 2020 - Keys2drive and RAA Advocacy

The South Australian Chapter arranged its very first webinar using the Zoom platform on the 12 June. A total of 45 people attended online to see presentations from Andrew Rasch (Research and Development Manager at Keys2drive) and Matthew Vertudaches (Traffic Engineer at the RAA).

Andrew gave an excellent overview of the innovative Keys2drive program, including its history, future and underlying methodology. This was followed by a summary of results from a Keys2drive report on how the program can help parents become better supervisors and improve the road safety of their children. Andrew also gave some insight into a recent independent review of the program.

Matthew followed with a very comprehensive presentation on some of the advocacy programs within the RAA's Safety and Infrastructure team, including Report A Road and Regional Road Assessments. Report A Road is a system that allows a member of the public to report a road safety issue that they have, which will then be investigated and followed up with road authorities as necessary. The Regional Road Assessment program is an extensive assessment of the road network within a region and considers feedback provided by hundreds of local residents, as well as consultation with local road authorities. The general process and methodology were presented, along with some of the findings of the recently completed Limestone Coast regional road assessment. Matthew also covered how the RAA is beginning to incorporate AusRAP star ratings into these assessments.

Attendees posted several questions and comments online which were answered by the presenters.

Thank you to the University of Adelaide for hosting the webinar on their Zoom platform. The webinar was considered a success and the Chapter is considering the next webinar which is planned for August.

SA Chapter Chair and Secretary
Jamie MacKenzie and Phil Blake

ACRS News

2020 ACRS AGM – THANK YOU FOR OUR LARGEST AGM ATTENDANCE IN 30 YEARS!

The College's AGM was held on Wednesday 17th June, for the first time a virtual-only event held using the Zoom platform. Thanks to the acceleration of activity we've all experienced recently, and especially over the last decade - the span of the current NRSS 2011-2020 - we experienced our largest turn out ever for an ACRS AGM.

Following is Martin Small's inaugural AGM address as President:

Acknowledgement

I would like to acknowledge that the land we meet on today across Australia and New Zealand is the traditional land of the first peoples, who will always hold special status as *tangata whenua*, the people of the land.

President's Report

It is a great pleasure to report to you. As President, my obligation in all matters is to the immediate and long-term health of the Australasian College of Road Safety. In this role, I draw upon the Maori concept of *kaitiakitanga*. This is a concept of guardianship and protection for the environment, and I believe it is relevant to our organisation. I cherish the guardianship role placed in me by the members of the College.

I think we must cherish our profession.

Having been a corporate and individual member for around ten years, I put my name forward for election on the Executive Committee in 2016 because I wanted to contribute further to our unique professional body.

Road safety is not an easy area of work. Yes, it is highly satisfying to have achieved a substantial win, but it is difficult to celebrate because the scale of trauma is so high. Reaching one peak, overcoming one obstacle, often reveals another.As change agents within a road traffic system which so routinely kills and maims, it often feels we are swimming against the tide. We have to work harder to get policy decisions made and investments agreed. We have to politely explain why someone's idea is highly unlikely to work, or articulate a future state that others consider outrageous or impracticable.

Change leadership is difficult. We all have our own roles in this, and we must cherish each other as we perform those roles. I would like to express my appreciation today for the daily efforts made by our personal and corporate members. Today, Lauchlan McIntosh and Liz de Rome step down from their roles on the Executive Committee of the College. Since the last AGM, Jeremy Woolley and Paul Graham have stepped aside for new Chapter Chairs in South Australia and New Zealand, and Blair Turner resigned when he took up a role overseas. All embody the inquiring mind, collegial spirit, and determination that we cherish, and they are a loss to the Executive Committee. There was an outstanding list of candidates for the Executive Committee, and so there is some renewal.

I think we must renew our organisation.

Like many organisations at this time, we have needed to take steps to protect the organisation. We have had to make the difficult decision to postpone the 2020 conference in Melbourne, and the subsequent conference in Christchurch. This will have a negative budget effect, but the progress

made over recent years means that we have been able to maintain our services to members. We cannot take anything for granted over the next two years however, and so we must be working harder and smarter behind the scenes.

The Strategic Review which was completed last year has led to adoption of a vision which is "Elimination of fatal and serious injury on the road", and a purpose which is "To support our members in their efforts to eliminate serious road trauma through knowledge sharing, professional development, networking and advocacy." New objectives have been developed and these will be incorporated in a revised Constitution which is being prepared, on behalf of the Executive Committee, for decision by you.

A less visible development is the preparation by our Chief Executive Officer Claire Howe of our first business plan. Each year, we must look again at our activity, ensure that it is aligned with our vision, purpose and objectives and take a clear look forward on our priorities. This is a critical point where we as members provide direction for our staff and our staff can articulate how they will respond.

Our organisation will stand and fall on the basis of our membership which provides us with a unique voice for road safety. We can speak with understanding, empathy and concern regarding all types of road users, all communities who are affected by road trauma, and all professions who bear responsibility for addressing road trauma. However, we must ask ourselves whether we are sufficiently representative of the communities we serve.

As Chair of the Australasian Road Safety Conference in Adelaide last year, and then as President of the College, I was delighted that we made a step forward in recognising the need for diversity and renewal with the establishment of the Young Leader's Oration award. We have some distance to go. What can and should we do to ensure that all genders, all ethnicities, and all professions are welcomed and contribute to our mission?

I think we must renew our policy and advocacy work.

Significant progress has been made in recent years to lift the profile of the College as a leading voice for road safety, in concert with like minded partner organisations. We must do more to leverage our professional knowledge and understanding and sharpen our demands. My focus has been on the national picture in Australia, but I have also sought to maintain connections in New Zealand.

In Adelaide last year Australian Ministers of Transport and Infrastructure committed to a vision of eliminating road fatalities by 2050 – we want this excellent vision to extend to serious injuries. New Zealand has published a reinvigorated national road safety strategy which returns to the essentials of ambitious target setting to 2030 – we want this to be a platform from which an elimination agenda by 2050 can become a reality.

I believe we must take 2050 as a guiding star, and advocate now for major initiatives which we know will make a major difference then.

- We have strongly endorsed a vision of eliminating fatalities and serious injuries by 2050
- We are seeking 50% reductions in fatal and serious injury by 2030, as part of a target setting approach which picks off the major issues we have to tackle
- We want to see safety star ratings published for all main road networks, and the preparation of a ten-year national safety investment budget to achieve 2030 infrastructure safety targets
- We want a national Regulatory Impact Statement prepared for lowering the default speed limits for urban roads and for rural roads
- We want to match European vehicle safety regulation over this decade, to introduce intelligent speed adaptation and autonomous emergency braking.

These were all expressed in a letter to the Transport and Infrastructure Council last month. In our submission to the Australian Parliament at the beginning of the year, we sought the establishment of a statutory office of road safety within the Federal Government. I encourage all personal and corporate members to advocate these policies, which are equally relevant in New Zealand.

I was delighted that several members outside the Executive Committee volunteered to assist in preparing this letter – Brett Hughes, Phil Blake and Lori Mooren. The policy and advocacy area in particular must be led by the members and their representatives on the Executive Committee.

Road safety results in Australia and New Zealand have been poor for some years now. We have been punching well below our weight. We can achieve much more, at great benefit to the economy. Now is the time to make demands that we know can lock in substantial improvements in the future.

We are an extraordinary organisation. I am proud to make a contribution to each edition of our peer reviewed Journal of Road Safety which is a defining feature of our work. I am delighted that the College has earned the trust of the Australian Government to establish an International Chapter. We have plenty of peaks and obstacles in front of us, but I am optimistic of our organisation's growing capacity to support your efforts to eliminate fatal and serious injury on the road.

To all our members, our Executive Committee, and our staff, thank you for your work and effort over this last year.

Martin Small
ACRS President

Following is ACRS **Chief Executive Officer Claire Howe**'s Report to Members:

'Reflecting on 10 years of ACRS progress during the NRSS Decade 2011-2020'

I am delighted to present my report covering our activities over the last 12 months, a very productive time for

the College which is especially significant given the unprecedented conditions we have been faced with. My obligation as CEO continues to be the immediate and long-term health of our College, an obligation which is particularly vital given COVID-19's ongoing impact on our operations.

I would especially like to recognise the major growth of our organisation over the last decade, the period of the current National Road Safety Strategy (NRSS 2011-2020). Despite the major disruption caused by the spread of COVID-19 the College has achieved a great. Key achievements over the last 12 months and beyond include the following:

1. Conferences

We had a fantastic 2019 conference in Adelaide – thanks to the strong support of our SA Chapter led by Jeremy Woolley and now Jamie Mackenzie. Preparations for the next 4 conferences – Melbourne, Christchurch, Gold Coast and Darwin, are well underway, however the effect of COVID-19 on all future conferences has been profound. A great deal of work has been undertaken to successfully postpone all events for 12 months with minimal disruption to all involved. I'd like to pass on my appreciation to everyone involved for their help in ensuring a smooth transition.

2. Government Grants

During the last 12 months we've been fortunate to receive 2 federal grants to support both our international outreach work plus our annual conferences and Scholarship Programs for colleagues from LMICs.

Again due to the effects of COVID-19 we're in the process of amending the Grants to ensure that all goals will be met.

3. International Engagement – UNRSC, LMIC's, Sweden, JRS

In February several College representatives including myself attended the *3rd Global Conference in Stockholm*. I was able to officially present our 2019 conference Declaration to the World Health Organisation, the Declaration having been signed by hundreds of members and stakeholders as a symbol of our collective support for global goals and leadership.

Other international engagement work included ongoing representation on the UN Global Road Safety Collaboration, expansion of our LMIC outreach to a mentoring program through the Journal and continuation of our LMIC Scholarship program & mentoring at our conferences. The International Outreach Grant will further extend our work in this area.

4. Communications

We are continually expanding the College's important communications programs. Over the last 12 months in particular we have:

- Rebranded the College with a new logo and new website and also rebranded the Journal
- Produce 4 editions of the journal & significantly strengthened the Journal Editorial Board to now include 18 eminent global professionals
- Implemented Digital Object Identifiers for each article and in May commenced direct journal Alerts to our full stakeholder database
- Undertaking an online survey asking for journal feedback. This was published yesterday so please take the time to complete it.
- Published 40 editions of Weekly Alert over the last year. This popular publication is in its 10th year and has undergone significant transformation with the re-brand.
- We have presented several formal federal submissions in addition to those presented via Chapters to their jurisdictions.
- We have embraced this new virtual environment (as you can see with this, our inaugural virtual-only AGM) and we're currently investigating best platforms to run webinars which is a major new work program for the College.

5. Awards

We have continued oversight of the prestigious College awards – the 3M Award, the Fellowship Award, and now the new Young Leaders Oration Award.

6. Strategic Review

We have continued to implement the outcomes from the Strategic Review and at this meeting are seeking 3 immediate updates to our Constitution to support this work.

7. Relationship Management

The Canberra-based office continues to play a key role in relationship management across the spectrum of road safety stakeholders, from our Patron the Governor-General to politicians and government leaders at all levels, and our broader partners across all sectors.

8. In closing….

Looking back at recent developments we are fortunate to have recently upgraded our operational capacity and systems so that we remain in a strong financial position.

For the last 4 months in particular, COVID-19 has had a significant impact on our workload. We have implemented a Business Continuity Plan, now a Business Plan, which has required many decisions to be taken by the Executive to ensure continuity of our organisation.

We've worked through a sudden change of work practices following the office closure, relying entirely on virtual work environments. I'd like to thank the entire team here for their ongoing dedication and commitment throughout this period – it has been amazing to say the least!

Thank you also to our 17 Executive members, 26 Fellows, hundreds of personal and corporate members, our many sponsors, hundreds of authors, editors and peer-reviewers, Chapter executive Committees and the many, many others who continue to support our organisation in our united aim to combat road trauma.

The last Decade has seen the College grow in so many ways, and I continue to be very proud of our achievements and look forward to the next Decade of growth with you all.

Thank you everyone!

Claire Howe
Chief Executive Officer – ACRS

Diary

These events may change due to COVID-19 situation. Please check directly with the event website for latest updates.

25-27 August
7th ICTTP
https://icttp2020.se/
Gothenburg, Sweden

27-29 September
International Alcohol Interlock Symposium
http://interlocksymposium.com/
Oslo, Norway

12-14 October
7th International DDI Conference
https://ddi2020.sciencesconf.org
Lyon, France

4-6 November
9th International Cycling Safety Conference
http://www.icsc-2020.net/app/netattm/attendee/page/92553
Lund, Sweden

15 November 2020
2020 ACRS Awards Ceremony
Sydney, Australia
https://theaustralasianroadsafetyawards.com.au/

15 – 22 November 2020
National Road Safety Week 2020
https://www.roadsafetyweek.net.au/road-safety-week
Australia

2020

AUSTRALASIAN COLLEGE OF
ROAD SAFETY
AWARDS

2020 ACRS Awards Ceremony
National Road Safety Week
Opening Ceremony
Sunday 15 November 2020 – Sydney

Entries Now Open!

Entries close at 5:00pm AEST on 1st September 2020

National Road Safety Week Opening Ceremony Sunday 15 November 2020 – Sydney

The Australasian College of Road Safety Awards continues the tradition of the original Australasian road safety awards and conferences by recognising and celebrating exemplary projects and people working hard across our region to save lives and reduce injuries on our roads.

These awards include the following presentations:

- The prestigious **Australasian College of Road Safety Fellowship Award** in recognition of exemplary contribution being made by an individual to road safety in Australasia.
- Australasia's premier road safety award recognising projects that exhibit exemplary innovation and effectiveness to save lives and injuries on roads – **the 3M-ACRS Diamond Road Safety Award**. This award is entering its 10th year and is recognised as Australasia's premier road safety award recognising an outstanding road trauma reduction project.

More information is available at:
www.theaustralasianroadsafetyawards.com.au

Presentation of a trip to the USA for exemplary road safety efforts!

Editorial

Road Safety into the Next Decade: Greater commitment and actions in LMICs

Lori Mooren PhD[1], Ray Shuey PhD[2], Mark King PhD[3], Chika Sakashita PhD[4], and Raphael Grzebieta PhD[5, 6]

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The 10th of April, 2020 marked the end of United Nations' Decade of Action for Road Safety. The target for this Decade was to reduce global road fatalities by 50% of the projected deaths of around 1.9 million –to below 900,000 deaths. However, by the year 2016 we saw the global road fatality toll rise to 1.35 million – and we still have around 1.35 million deaths per year[1].

Road trauma rates vary considerably with the income levels of countries. "With an average rate of 27.5 deaths per 100,000 population, the risk of a road traffic death is more than three times higher in low-income countries than in high-income countries where the average rate is 8.3 deaths per 100,000 population.[1]" The United Nations Road Safety Collaboration (UNRSC), established in 2004 under the leadership of the World Health Organisation (WHO), has been working hard to redress this imbalance. The 3rd Global Ministerial Conference on Road Safety was held in Stockholm in February, 2020. In the WHO Director-General's opening remarks, Dr Tedros said, "As low- and middle-income countries (LMICs) develop, they are in a position to avoid the costly mistakes made in the past by high-income countries."

The 3rd Ministerial Conference on Road Safety culminated in a renewed enthusiasm to raise the global commitment to action for road safety. The Conference produced a statement setting a target of reducing road deaths by 50% by 2030 and specifying 12 road safety performance targets[2]. Sadly, the timing of this statement coincided with the advent of the global COVID-19 pandemic. Like most public health threats, COVID-19 will no doubt affect LMICs more intensely than high-income countries (HICs.) Moreover, it may well overshadow the road death and injury pandemic. The UNRSC is trying to find ways to keep road safety high on the public agenda. COVID-19 also potentially brings increased road trauma risk with more vulnerable road users taking to walking and cycling rather than using public transport. Also, as there is generally less motorised traffic due to lockdowns, motor vehicle speeds are likely to go up, presenting more, and more serious, injury risks. Now is the time to make even stronger commitments and greater evidence-based actions in road safety globally.

The restrictions on international travel and in-country lockdowns are resulting in road safety projects being delayed. Indeed, two of us experienced, first-hand, the disappointment of an important speed management demonstration project being delayed due to COVID-19 outbreaks in the Islamic Republic of Iran. The Eastern Mediterranean Region of the WHO had already decided to use this project to advance a model of good practice speed management interventions across that Region.

The Australasian College of Road Safety (ACRS) hosts an Annual Road Safety Conference to share latest research and good practices. Increasingly, this Conference is seeing an increase in international delegates. Funded by the Australian Department of Infrastructure, Transport, Cities and Regional Development, scholarships to support participation in this Conference have been awarded to people working in LMICs each year since 2016. This has enabled a two-way flow of knowledge and experience between HICs and LMICs. Following the 2019 Conference, it was decided to produce this Special Issue of the J*ournal of Road Safety* with a focus on contributions from or about LMICs. The *Journal of Road Safety* also offers a mentorship program to provide capacity development support for authors from LMICs and contribute to the improvement of road safety in LMICs. So, while the 2020 Australasian Road Safety Conference has been deferred until September, 2021 due to the COVID-19 pandemic, we can still enable good practice exchanges through this Journal.

1 World Health Organisation, Global Status Report, 2018 https://apps.who.int/iris/bitstream/handle/10665/277370/WHO-NMH-NVI-18.20-eng.pdf?ua=1
2 https://www.who.int/violence_injury_prevention/road_traffic/ministerial-conference-2020/en/

2019 LMIC Scholarship recipients at the ACRS Gala Dinner

Photo from left to right: Dr Ray Shuey, Ms Christine Paguirigan (Philippines), Mr Ali Zayerzadeh (Iran), Mr Arif Uddin (Bangladesh), Mr Llew O'Brien, then co-Chair of the Parliamentary Friends of Road Safety and Chair of the Joint Select Committee into Road Safety, Mr Martin Small ACRS President, Ms Sumana Narayanan (India), Ms Le Nguyen, (Vietnam), Dr Lori Mooren

On the final day of the 2019 Conference in Adelaide, Australia a focus group session was undertaken with the five LMIC Scholarship recipients. The awardees were from Bangladesh, India, Iran, Philippines and Viet Nam and had been assessed for the award through a peer review process. The general consensus and themes presented by the recipients included:

- It was generally agreed that road safety issues in HICs and LMICs were essentially the same. It is really a matter of scale, especially fatality ratios, population and traffic density;
- In the road safety environment, there is a need to develop a mindset change within the communities to that of safety in attitude, behaviour and culture. i.e., to establish a road safety culture;
- In LMICs, the NGOs can rally more community emotion and use data at a community level for road safety benefits. Additionally, NGOs have a more focused ability to address and engage the different language and culture groups in the community.
- Successful programs in one country can be transferrable to another country (with relevant modifications);
- Lack of resources is not an acceptable excuse. A lot can be done with limited resources by understanding and undertaking resource optimisation. In their experience, substantial gains have been achieved with minimal resources;
- If the law is not in place and safety issues are involved, you can still proceed with advocacy to achieve safety outcomes e.g. child restraints. Safety outcomes can be achieved in the interim;
- Social media is a very effective tool for community messages to inform the general public about critical safety issues;
- Road safety shares common challenges internationally and the sharing of these challenges, responses and interventions is a contributing factor in road trauma reduction.

In this Special Issue, we encouraged authors to submit papers on road safety in LMICs for peer review. The four peer-reviewed papers cover:

- Lack of pedestrian safety in Chennai, India;
- Impact of density and urban design features on road safety outcomes in Bogota, Colombia
- Availability and usage rates of seat belts in Malawi; and
- Analyses of the context of speed management in Cambodia to improve implementation.

In addition, we have three contributed articles:

- Good practice road safety examples in LMICs;
- Features of LMICs making road safety more challenging; and
- Review of road safety management and infrastructure in Romania and recommended actions.

We hope you find this Special Issue interesting and helpful in your work.

Peer-reviewed papers

Original Road Safety Research

Pedestrian Safety in Chennai

Sumana Narayanan

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Key Findings

- Pedestrian-focussed interventions have not been effective in Chennai
- Pedestrian infrastructure in the city is inadequate and putting pedestrians at risk
- Pedestrians do not feel safe on the city's roads

Abstract

Pedestrian and cyclist safety are not considered by urban planners or road users in India. Data on road crashes tend to underreport crashes involving this group. In spite of adopting a Non-Motorised-Transport (NMT) friendly policy in 2014, Chennai city in Tamil Nadu continues to prioritise motorised transport. Five years after the NMT Policy adoption, pedestrian infrastructure was assessed in 11 locations. A perception survey of 37 road users was also conducted as the Policy calls for changing the mindset of motorists towards pedestrians. The pedestrian infrastructure assessment found that footpath and pedestrian crossings are inadequate with only six locations having contiguous, wide, walkable footpaths for some distance. Even in these locations, the footpath is encroached upon by parked vehicles, garbage, utilities, and shops. Even roads which have seen pedestrian-focussed interventions fall short. Pedestrian infrastructure, what little exists, is not friendly towards the elderly and people with disabilities. The perception survey suggests that pedestrians are not safe on the roads and that motorists do not slow down or stop for pedestrians. Some motorists (autorickshaw drivers and bus drivers) felt that pedestrians put themselves at risk by walking on the road and crossing the road as they please. Pedestrians interviewed, however, pointed out that footpaths are few, and those that exist are encroached upon, forcing pedestrians to walk on the road. In spite of being the first city in India to adopt an NMT Policy, many pedestrians continues to be precarious.

Key Words

Pedestrian, Road Safety, Chennai, Non-Motorised Transport Policy

Glossary

AMRUT – Atal Mission for Urban Rejuvenation and Transformation
CAG - Citizen consumer and civic Action Group
GCC - Greater Chennai Corporation
IIT- Indian Institute of Technology
JNNURM – Jawaharlal Nehru National Urban Renewal Mission
MVA - Motor Vehicles Act, 1988
NMT - Non-Motorised Transport

Introduction

In India, Non-Motorised Transport (NMT) such as pedestrians and cyclists are generally not considered in city and infrastructure planning. For example, the Motor Vehicles Act 1988, does not concern itself with NMT except for passing references in terms of motorists giving way to pedestrians at pedestrian crossings (Ministry of Surface Transport, 1988). However, the National Urban Transport Policies of 2006 and 2014 highlight the need for more sustainable and NMT-focussed transport planning (Ministry of Shipping, Road Transport and Highways 2006; Ministry of Road Transport and Highways 2014). The Ministry of Surface Transport was renamed the Ministry of Shipping, Road Transport and Highways in 2004 and in 2009 it became the Ministry of Road Transport and Highways.

Vehicle ownership is an aspiration: first a two-wheeler and then a car (Doherty, 2012; Ghosh and Bhasin, 2015; Saleem, 2016). In last few decades, Chennai, the capital of the southern state of Tamil Nadu, has seen rapid urbanisation and an increased motor vehicle population from 60,000 in 1984 to 5,394,413 in 2018 (Chennai Metropolitan Development Authority, 2008; Tamil Nadu State Transport Authority, 2018). During this period, the number of two-wheelers was observed to experience a 49-fold increase from 87,000 to 4,254,811 (Chennai Metropolitan Development Authority, 2008; Tamil Nadu State Transport Authority, 2018). A look at the latest data, from 2008, on changing trip modal shares shows that between 1970 and 2008, the share of two-wheelers rose 18%, cars rose 5%, trains by 1% while buses dropped by 33%, cycles by 31%, and pedestrians by 2% (ITDP, 2013).

This has led to congested roads. The response of government agencies has been to widen roads at the expense of footpaths and trees; introduce one-way roads; build flyovers; increase road median height; build subways or foot overbridges instead of at-grade crossings – all in the name of ensuring smooth traffic flow. This has, of course, eased traffic flow for a brief period followed by more congestion as more vehicles are added to the roads (Slobodan and Chatterton, 2005).

However, in 2014, Chennai's municipal corporation, the Greater Chennai Corporation (GCC), launched the city's NMT Policy, making Chennai the first city in India to draft and implement a NMT policy (Philip, 2019; "About Cycle Sharing System," n.d.; "History of ITDP," n.d.). The Policy aims to increase the patronage of cycling and walking by creating a conducive environment of cycle paths and pedestrian spaces with the goals of ensuring greater access and mobility for all; social and economic empowerment through provision of low-cost mobility; gender equity (safe NMT spaces); social inclusion (NMT facilities that are accessible and usable by all); reduced impact on the environment; a culture of acceptance of cycling and walking as aspirational modes of transport; and community participation in designs and standards to foster active use and a sense of ownership of these spaces (Greater Chennai Corporation, 2014).

The Policy states that the GCC would come out with guidelines and instructions regarding priorities in designing of transport facilities i.e., prioritising NMT and public transit. The GCC would also incentivise its own staff and those of other institutions/organisations to use NMT and public transit in their daily commute (Greater Chennai Corporation, 2014). The Policy notes that its effectiveness would be measured via the following indicators (Greater Chennai Corporation, 2014):

- Increased mode share for pedestrians, cyclists, public transport
- Decreased traffic crashes involving pedestrians and cyclists
- Increased footpath, cycle track coverage
- Decreased personal motor vehicle kilometres travelled.

Unfortunately, five years later, there have been no studies to verify if the goals set in the Policy have been achieved in any measure. The Policy does not lay out any targets in terms of number/extent of roads to be redesigned or a timeframe. The GCC, has however, according to media reports, said that they plan to start with 100 roads which they say they have completed. Details on these roads are not available in the public domain. This paper assesses some key areas of the city for pedestrian infrastructure. As a part of the implementation of the NMT Policy, GCC has in the past 5 years, made pedestrian-focussed interventions in a few locations (Luz Church Road, Harrington Road, Indira Nagar 1st Ave, Besant Nagar 1st Ave, and Anna Nagar). The first three locations mentioned above have been included in the 11 sites assessed. This paper also attempts to understand if there have been gains made in promoting *a culture of acceptance of cycling and walking as aspirational modes of transport* through a perception survey of various road users' perception of pedestrian rights and safety.

Methodology

Pedestrian Infrastructure Assessment

Between October 2019 and December 2019, pedestrian infrastructure was assessed in 11 locations.

The site survey locations were chosen based on the following variables:

1) Geography of the city – North, Central, South, and peri-urban Chennai

2) Land use classification

Of the 11 sites surveyed (Table 1), three (sites 9, 10, 11) are locations where the GCC has redesigned the street to include footpaths that are wide, accessible, etc.

At each site, pedestrian infrastructure was assessed for a one kilometre stretch of road by measuring the following variables:

1) Width of footpath. This was measured qualitatively by estimating how many people could walk abreast on the footpath

Table 1. Land use classification

Site Number	Specific Locality	Location	Land Use
1	Rajaji Road	North Chennai	commercial
2	NSC Bose Road	North Chennai	commercial
3	Clements Road & Thakkar Street, Purasawalkam	North Chennai	residential
4	Usman Road	Central Chennai	commercial
5	Poonamallee High Road	peri-urban Chennai	commercial
6	Dandapani Street, T.Nagar	Central Chennai	residential
7	Mount Road, Saidapet	Central Chennai	commercial
8	Sardar Patel Road, Adyar	South Chennai	commercial
9	Indira Nagar 1st Avenue	South Chennai	residential
10	Luz Church Road	Central Chennai	commercial
11	Harrington Road	Central Chennai	commercial & residential

2) Continuity of footpath. This was estimated qualitatively as a percentage of the entire distance e.g. less than 25% of the 1 km assessed was contiguous. Continuity was defined as where the footpath was wide enough for at least 1 person to walk on without stepping into traffic

3) Surface quality of footpath was measured qualitatively in terms of whether the tiles were evenly laid, and not slippery

4) Presence, nature, and extent of encroachments. All types of encroachments were accounted for; the percentage of footpath encroached upon was estimated.

5) Walkability of footpath was measured in terms of whether a pedestrian could walk the surveyed stretch without stepping off the footpath; and

6) Accessibility of footpath was measured in terms of whether there were ramps when there was a gradient change at intersections and at driveway entries, as well as if the footpath useable by people with disabilities in terms of whether a wheelchair could navigate the footpath; were there aids for the blind.

Pedestrian crossings, foot overbridges, and subways were also assessed by measuring:

1) Accessibility, in terms of presence of an escalator, elevator, or ramp

2) Safety in terms of whether the infrastructure saw constant movement of commuters and whether it was well-lit;

3) Cleanliness in terms of presence of garbage and whether the area smelled of urine, and

4) Duration of pedestrian lights in the case of at grade crossings. The green light for pedestrians was timed.

Pedestrian Perception Survey

In addition, a perception survey of 37 road users was performed. The road users were chosen by gender, age, and type of vehicle being driven. The road users surveyed were eight auto rickshaw drivers, seven car drivers, seven two-wheeler riders, four bus drivers, and 11 pedestrians. The perception survey was carried out to understand how they view pedestrian rights and pedestrian safety. The bus drivers and auto rickshaw drivers were all men since women drivers in these categories are very rare.

The pedestrian infrastructure assessment and pedestrian perception survey were conducted using checklists (Appendix A). The app, KoboToolbox, was also used in the pedestrian infrastructure assessment.

The Pedestrian Infrastructure Assessment and the Pedestrian Perception Survey were carried out by a team of 4 people. To ensure consistency in data collection, a training session on the checklists and the app, KoboToolBox was conducted prior. A field trial was also carried out and a follow up discussion to clarify doubts was held.

A number of limitations were identified during this study. Firstly, the sample size of 37 participants in the perception study and 11 locations is small; secondly, the influence of religion, lighting, gender on infrastructure usage was not considered. Finally, footpath width and continuity were qualitatively assessed rather than quantitatively assessed. Footpath measurements were not taken due to safety and security issues.

Results

Pedestrian Infrastructure Assessment

The results from the pedestrian infrastructure assessment in 11 sites are presented in Table 2 and Table 3.

Table 2. Assessment of pedestrian infrastructure - footpath usability and accessibility

Site Number	Specific locality	Footpath is 2 people wide or more	Footpath surface (even or broken tiles)	Footpath which is contiguous	Amenities on the footpath	Obstructions/encroachments on the footpath	% of ramps/ slopes at the driveway/ entrances/ road intersection with slopes	Distance between bollards (wide enough for 1/2/3 people)
1	Rajaji Road	>75%	50%; broken tiles, uneven	75%	Bus shelter with seating, street lights	Shops, vehicles, temples, electricity box, roadside vendors, trees	25 -50%	No bollards
2	NSC Bose Road	25-50%	>75%	>75%	Street lights	Shops, vehicles, electricity box, roadside vendors, garbage	75%	1 person
3	Clements Rd & Thakkar St, Purasawalkam	<25%	<25%; uneven, broken tiles	25-50%	Street lights	Shops, vehicles, electricity box, roadside vendors, garbage	50-75%	No bollards
4	Usman Road	50%	50%	<50%	Bus shelter, trees	Shops, vehicles, electricity box, temples, roadside vendors, garbage, hoarding, construction debris	<25%	<1 person
5	Poonamallee High Road	0	0	0	0	Shops, vehicles, temples, roadside vendors	0%	No bollards
6	Dandapani St, T.Nagar	25-50%	25-50%	<25%	Trees	Vendors, vehicles, hoarding, landscaping, temples, electricity box, transformer, garbage	<25%	No bollards
7	Mount Road, Saidapet	>75%	>75%; broken tiles	100	Bus shelter with seating, shade trees	Shops, vehicles, street lights, bus shelters	25-50%	1 person
8	Sardar Patel Road	25-50%	25-50%; uneven	<25%	Trees, bus shelter	Garbage, parked vehicles, water stagnation, transformer	None	No bollards
9	Indira Nagar 1st Ave	50-75%	75-100%	75-100%	Trees	Parked vehicles, trees, garbage, electricity box	>75%	1 person
10	Luz Church Road	50-75%	>75%	50%	Trees, bus shelter	Parked vehicles, shops, vendors, garbage, electricity box	50%	1 person
11	Harrington Road	25-50%	50-75%	100%	Trees	Shops, trees, vendors, electricity box	50-75%	1 person

Table 3. Assessment of pedestrian infrastructure - crossings and crossing facilities

Site Number	Pedestrian Crossing			
	Clearly marked	With lights	Lights working	Duration of lights (in seconds)
1	Yes	Yes	Yes	10
2	None	No	NA	NA
3	None	No	NA	NA
4	a) Yes	No	NA	NA
	b)Yes	No	NA	NA
	c)Yes	No	NA	NA
	d)Yes	No	NA	NA
	e)Yes	No	NA	NA
5	None	No	NA	NA
6	None	No	NA`	NA
7	a)No	Yes	Yes	25
	b) No	Yes	Yes	30
	c) Yes	Yes	Yes	30
8	None	No	NA	NA
9	None	No	NA	NA
10	Yes	No	NA	NA
11	Yes	No	NA	NA

In the 11 sites, there was only one FOB and one subway. The FOB was in site 7, and while the steps were unbroken, the FOB was not clean. There were no homeless people using the FOB as shelter. The subway was in site 1; the steps were not broken and the subway was clean. There was, however, some water stagnation. There were no homeless people using the subway as shelter.

The results from the perception survey of 37 road users on pedestrian safety are summarised below (see Appendix B for full survey results).

1. Rickshaw drivers agreed that pedestrians do have rights on the road (5/8 interviewees) and in general said that to make pedestrians safe, we need wider roads, better footpaths, parking space, and greater regulations. They also felt that motorists are in general considerate towards pedestrians (5/8).
2. Car drivers agreed that pedestrians do have rights on the road (6/7), felt that pedestrians are not safe in Chennai (7/7), and that what was needed was wider roads with pedestrian spaces/footpaths, proper traffic regulation and parking systems. They also largely agreed that motorists are not considerate towards pedestrians (6/7).
3. Two-wheeler riders were divided over whether pedestrians had any rights (4/7 said yes); what was needed was better roads, removal of roadside vendors, footpaths were bikes cannot enter, and better regulation/enforcement. They also were divided on whether motorists are considerate towards pedestrians.
4. Bus drivers felt that pedestrians did not have any rights on the road (4/4) but vehicles have to stop for pedestrians (so as to not kill them); what was needed for pedestrians to walk on the footpath, removal of encroachments, and better footpaths. They also felt that motorists are considerate towards pedestrians.
5. Pedestrians said that footpaths are not adequate; motorists do not give way or show any consideration to pedestrians; motorists speed and drive in all directions making walking a scary experience and footpaths are encroached upon by shops and parked vehicles.

Discussion

Pedestrian Infrastructure Assessment

From the data collected (see Table 2 and Table 3), in six out of 11 places surveyed, the footpath width, continuity, quality is poor. The sites that had good footpath (i.e., wide enough for two people to walk, evenly tiled, and with contiguous stretches of footpath) for at least 50% of the surveyed length were Rajaji Road in North Chennai (site 1 in Table 2 and Table 3), Mount Road, Luz Church Road, Harrington in Central Chennai (sites 7, 10, and 11 in Table 2 and Table 3), and Indira Nagar in South Chennai (site 9 in Table 2 and Table 3). However, none of the sites surveyed fared well in terms of encroachment. At all sites the footpath was encroached upon by shops, roadside vendors, parked vehicles, and garbage. Similarly, none of the sites were access-friendly; roads that had ramps to access the footpath also had inappropriately-placed bollards making footpaths inaccessible for wheelchairs.

Rajaji Road (Figures 1 and 2) in North Chennai (site 1 in Table 2 and Table 3) has narrow footpaths (just enough for one person) for most of the distance surveyed with short stretches being wide enough for two people to walk abreast. On the eastern side, i.e. along Beach Station, the footpath is narrow, just enough for one person to traverse it. It was observed during data collection that this stretch has a row of small shops that have encroached upon the footpath and so pedestrians have to skirt their customers who have no place to stand but the footpath. It was observed that most pedestrians walked on the road due to encroachment of the footpath and due to footpath access being blocked by a row of parked two-wheelers. The western side of the road is marginally better with short stretches of 100m having slightly wider footpaths but these too are occupied by roadside vendors, bus stops, and the subway entrance, leaving little space for the pedestrian.

In the commercial areas of NSC Bose Road, Usman Road (sites 2 and 4 in Table 2 and Table 3), and Sardar Patel Road (Site 8 in Table 2 and Table 3; Figures 3 and 4) less than 50% of the road had a footpath wide enough for two people to walk abreast. Of the three, only NSC Bose Road (site 2)

had less than 50% of the footpath surface broken or uneven. Again in all three locations, the footpath was encroached upon by road side vendors, shops, garbage (in bins or strewn on the ground), parked vehicles, and utilities such as electricity junction boxes.

In the residential roads in Purasawakkam, T. Nagar (Figures 5 and 6), and Indira Nagar (sites 3, 6, and 9 in Table 2 and Table 3), only Indira Nagar had contiguous, and neatly laid footpaths. However, all three surveyed road had encroachments on the footpath consisting of garbage, utilities, and parked vehicles.

In Harrington Road (site 11 in Table 2 and Table 3), the footpath is wide and in good repair albeit with a little encroachment by shops and utilities. As seen in Table 2 and Table 3, Harrington Road has wide footpaths on either side, evenly laid, with bollards to prevent vehicles from driving on them. There is a clearly marked at-grade pedestrian crossing with median refuge and curb extensions.

In Luz Church Road (site 10 in Table 2 and Table 3; Figures 7 and 8), for a short distance (about 600 m), the footpath is about 3m wide and has clearly been designed with the pedestrian in mind. However, the footpath width abruptly changes from 3m width to about 1m wide. Throughout, be it in the wider or narrower sections, the footpath is encroached by shops, vendors, temples, parked vehicles, and garbage.

In terms of facilities for pedestrians to cross the road, most sites did not have any. In one site, Mount Road (site 7 in Table 2 and Table 3), there is a grade crossing with a pedestrian light and a foot overbridge right next to each other. During data collection, it was observed that pedestrians did not use the foot overbridge and preferred to wait for the pedestrian light to turn green to cross the road. It was also observed that the time given for pedestrians to cross the road was 30 seconds and the road is 5 lane-wide one-way without any median refuge causing even able-bodied, young pedestrians to hustle across.

In Rajaji Road (site 1 in Table 2 and Table 3) there is one subway and one at-grade pedestrian crossing with a 10 second pedestrian light. It was observed that the duration of the light was inadequate for pedestrians to cross the road; they were only able to cross halfway. The subway was in good repair and it was observed to have heavy patronage by people accessing the adjacent suburban railway station.

Usman Road (site 4 in Table 2 and Table 3) had the maximum number of pedestrian crossings - four at-grade crossings but without pedestrian lights.

Luz Church Road (site 10 in Table 2 and Table 3) had one at- grade crossing without lights. It was observed during data collection, that while there was no median refuge, there is a traffic police booth in the middle of the road next to the crossing which pedestrians used as a median refuge.

Poonamallee in peri-urban Chennai (site 5 in Table 2 and Table 3) had no pedestrian infrastructure - no footpaths, no pedestrian crossing though the road is a highway and a busy local bus station is situated there.

Pedestrian Perception Survey

As the perception study data (Appendix B Table 4) shows, while almost all motorists interviewed admit pedestrians have rights for many it was limited to footpaths and crossing at pedestrian crossings. Some motorists felt that in many roads, footpaths are being constructed so pedestrians should be fine. The main problem cited by survey respondents was that pedestrians insist on walking on the road. However, the majority of motorists interviewed believed that roads were not pedestrian-friendly and that motorists don't wait for pedestrians.

Table 5 shows that pedestrians were clear that walking in Chennai is hazardous to health – motor vehicles give scant regard to them; footpaths are non-existent; and crossing roads is difficult as vehicles do not slow down even at pedestrian crossings. Pedestrians interviewed (Appendix B Table 5) highlighted issues around footpath quality and extent, they also noted that motorists tend not to give pedestrians any room. In addition, pedestrians interviewed noted that motorists drive haphazardly making the pedestrian experience more traumatic. Pedestrians were emphatic that they did not feel safe on the city's roads and two major changes were required - one was the quality of footpaths, and the second was recognition of pedestrians as a legitimate road user by motorised vehicles.

Figure 1. Site 1 – Rajaji Road (Source: Harish Baskar, CAG)

Figure 2. Site 1 – Rajaji Road: Footpath encroached upon (Source: Harish Baskar, CAG)

Figure 3. Site 8 – Sardar Patel Road (Source: Sumana Narayanan, CAG)

Figure 4. Site 8 – Sardar Patel Road (Source: Sumana Narayanan, CAG)

Figure 5. Site 6 – Dandapani Street (Source: Venkat Ramshankar)

Figure 6. Site 6 – Dandapani Street (Source: Venkat Ramshankar)

Figure 7. Site 10 - Luz Church Road: Redesigned footpath encroached upon by vehicles, temple, shops
(Source: Sumana Narayanan, CAG)

Figure 8. Site 10 – Luz Church Road: Footpath encroached upon by roadside shops

(Source: Sumana Narayanan, CAG)

Conclusion

This paper assesses some key roads of Chennai city in terms of pedestrian infrastructure including specifically where the Greater Chennai Corporation has made pedestrian-focussed infrastructure a priority. The site survey was conducted in 11 locations in North, Central, South, and peri-urban Chennai. The site survey, using KoboToolbox, assessed the width, contiguity, accessibility, and extent of encroachment of footpaths

This paper also sought to understand if there have been gains made in promoting a culture of acceptance of cycling and walking as aspirational modes of transport through a perception survey where various road users' perception of pedestrian rights and safety was looked at. The perception survey of 37 road users, consisting of motorists and pedestrians, assessed their opinion on how safe the city was for pedestrians, and whether pedestrians had an equal right, as much as motorists, to the road.

In terms of pedestrian infrastructure, the data collected showed that of the 11 locations only 5 had a reasonable extent of useable footpath and even this was encroached to varying degrees. Even the much-vaunted examples of footpath redesign (Harrington Road and Luz Church Road) show that these redesigns are only for short stretches where the road is quite wide to start with and here too there is encroachment. Harrington Road, is possibly, the best of the lot, with the least amount of encroachment of any kind, better levels of cleanliness and maintenance of the space.

During data collection it was noted that footpath redesign at the sites also indicate that often bollards are closely placed making the footpath inaccessible to the differently-abled pedestrians. In some cases footpath tiles are extremely smooth and polished, posing a potential slip hazard to pedestrians.

If after pedestrian-focussed redesign, wide roads like Harrington Road and Luz Church Road continue to be pedestrian unfriendly, it begs the question, what does the GCC plan for narrower roads? In many parts of the city, road width is such that two cars will be hard-pressed to pass each other.

The perception survey found that while most motorists agreed that pedestrians have the right to safely use the road and that other road users are inconsiderate towards pedestrians. A few motorists, notably autorickshaw drivers and bus drivers felt that pedestrians are quite safe as there are footpaths for them and if pedestrians' lives are at risk it is because they refuse to walk on the footpath and insist upon darting across the road. Pedestrians interviewed clearly felt they were unsafe on the roads; the footpaths are non-existent and what footpath exists is encroached upon, and other road users do not slow or stop for pedestrians.

At the national level, there are some regulations and policies that mention pedestrian safety such as the National Urban Transport Policies of 2006 and 2014 and the Central Motor Vehicles Rules. However, these are legally non-binding and as the site survey and perception survey show, not much has been achieved in terms of pedestrian safety in Chennai.

At the city-level in the past decade Indian cities have begun developing NMT policies and walkability plans. Chennai was the first Indian city to come out with such a document with its 2014 NMT Policy. The GCC piloted this by redesigning 100 roads to make them pedestrian-friendly. While media reports talk of this pilot, there are no documents in the public domain to indicate the criteria for choosing specific roads, or why 100 roads were decided on, and what the timeframe was for the pilot phase. Neither is there any information on the redesign process, nor on the success rate in implementing these plans. This study is the only known evaluation of the implementation of the NMT Policy of 2014 from site surveys. The findings from this study indicate that improvement of pedestrian infrastructure has been haphazardly implemented, with a few roads getting footpaths for short distances but little being done to ensure footpaths are contiguous and kept free of encroachment. In addition, the study found pedestrian road crossing infrastructure to be inadequate in all the 11 sites surveyed.

If Chennai is to achieve the goals stated in its NMT Policy and become a more sustainable,

liveable city, it needs to be serious about improving NMT facilities and access. The changes required will take several years and therefore the political will and public interest to see these through is required.

Future studies could include a larger sample size in terms of locations surveyed and people interviewed; include variables such as religion, gender, lighting, safety; quantitative assessment of footpath width and continuity; and a more comprehensive assessment of footpath accessibility for different stakeholders (the elderly, the differently-abled)

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Appendix A

Pedestrian Infrastructure Survey

1)	Location:	
2)	Date:	
3)	Which side of the road are you surveying?	
4)	Is the footpath wide enough for two people to walk comfortably:	
	• For less than 25% of the road	
	• For 25 to 50% of the road	
	• For 50 to 75% of the road	
	• For more than 75% of the road	

5)	Is the footpath surface even, with smooth but not slippery tiles and no cracked / broken tiles?	
	• Less than 25% of the existing footpath surface is good	
	• 25 to 50% of the existing footpath surface is good	
	• 50 to 75% of the existing surface is good	
	• More than 75% of the existing footpath surface is good	
6)	Amenities available on the footpath	
	• Bus shelter with seats/ bench	
	• Bus shelter without seats/ bench	
	• Shade giving trees	
	• Chair/benches (stone ones)	
	• Toilets	
	• Others (List)	
7)	List of obstructions/encroachments on the footpath	
	• Parked vehicles	
	• Hoardings	
	• Landscaping	
	• Religious places	
	• Tamil Nadu Electricity Board (TNEB) junction box	
	• Street lights	
	• Road side vendors	
	• Shops	
	• TNEB transformers	
	• Trees	
	• Garbage bins	
	• Garbage thrown on footpath	
	• Construction material	
	• Other (list)	
8)	Are there ramps/slopes at the driveway/ entrances/ road intersection	
	• No ramps at all	
	• In less than 25% of the driveways	
	• In 25 to 50% of the driveways	
	• In 50 to 75% of the driveways	
	• In more than 75% of the driveways	
9)	Are there bollards where the footpath meets the driveway?	
	• No bollards at all	
	• In less than 25% of the drive ways	
	• In 25 to 50% of the driveways • In 50 to 75% of the driveways	
	• In more than 75% of the driveways	
10)	On average what is the distance between the bollards	
	• Pedestrian has to turn and walk sideways to walk between the bollards	
	• Wide enough for a person to walk between bollards without turning sideways	
	• Wide enough for 2 people to walk between bollards without turning sideways	

11)	Is there a pedestrian crossing?	
12)	Is it a pedestrian crossing with a pedestrian light?	
13)	Is the pedestrian light working?	
14)	If yes, what is the duration of the pedestrian light?	
15)	Is the pedestrian crossing clearly marked?	
16)	Is there a foot overbridge?	
17)	Are the steps of the foot overbridge broken?	
18)	Is the foot overbridge free of water stagnation?	
19)	Is the foot overbridge clean?	
20)	Is the foot overbridge occupied by beggars or homeless people?	
21)	Is there a subway?	
21)	Are the steps of the subway broken?	
22)	Is the subway free of water stagnation?	
23)	Is the subway clean?	
24)	Is the subway occupied by beggars or homeless people?	

Pedestrian Perception Survey

Perception of motorists on pedestrian safety

1)	Date	
2)	Location	
3)	Road user interviewed	
	• Car driver	
	• Two-wheeler rider	
	• Auto rickshaw driver	
	• Bus driver	
4)	Age	
5)	Gender	
6)	In your opinion, do pedestrians have any rights on the road? If yes, what are they?	
7)	Do vehicles have to stop for pedestrians?	
8)	At intersections/traffic lights, where should vehicles stop?	
9)	Do you feel pedestrians are safe in Chennai? Justify.	
10)	What needs to be done to make Chennai's roads safer for pedestrians?	
11)	Do you feel people driving (cars, bikes, buses etc) are considerate towards pedestrians?	

Perception of pedestrians on pedestrian safety

1)	Date	
2)	Location	
3)	Age	
4)	Gender	
5)	How often do you walk on the roads?	
6)	As a pedestrian, do you feel safe walking in Chennai? Explain.	
7)	What are the problems faced by you while walking?	

Appendix B

Table 4. Perception of motorists on pedestrian safety

Number	Road User	Age	Gender (M/F)	Do pedestrians have any rights on the road?	Do vehicles have to stop for pedestrians?	At intersections / traffic lights, where should vehicles stop?	Do you feel pedestrians are safe in Chennai?	What needs to be done to make Chennai's roads safer for pedestrians?	Do you feel people driving (cars, bikes, buses etc) are considerate towards pedestrians?
1	Auto rickshaw driver	43	M	No	No	Before the stop sign	Yes. New platforms and footpaths are being developed everywhere. So they are safe now	Widen the roads and put in place proper regulations.	Yes. Vehicles always stop when pedestrians are walking out crossing the road.
2	Auto rickshaw driver	49	M	Yes. they should have the right to walk safely	Yes	Before the stop line	Yes. They are safe because the roads are getting better and there are traffic police everywhere these days. So it's safe for them	As I said it's already Fairly safe. Apart from that, since pedestrians walk on the roads, it'll be better to build good footpaths.	Yes. I think most of them are. They will all stop when they see a group of people trying to cross the road.
3	Auto rickshaw driver	47	M	No, they should just be able to walk on platforms. That shouldn't encroach upon roads.	Yes	Wherever other vehicles stop.	No. As said before, pedestrians should be able to walk on platforms. But these footpaths are not even there in most places.	The roads should be expended and properly laid.	Yes. (Didn't give explanation)
4	Auto rickshaw driver	46	M	Yes, they should be able to walk without any trouble at any point of time.	Yes	Before the stop line	Yes. If they walk in the corner of the streets, they would be safe. If they walk in the middle of the street, they are going to get hurt.	Better roads and better traffic regulation	I am considerate, but I don't know about others. I stop whenever I see that people are trying to cross the road.

Number	Road User	Age	Gender (M/F)	Do pedestrians have any rights on the road?	Do vehicles have to stop for pedestrians?	At intersections / traffic lights, where should vehicles stop?	Do you feel pedestrians are safe in Chennai?	What needs to be done to make Chennai's roads safer for pedestrians?	Do you feel people driving (cars, bikes, buses etc) are considerate towards pedestrians?
5	Auto rickshaw driver	52	M	Yes, they should feel safe while crossing or walking on the roads.	Yes	Before the stop line	No. Because most people don't stop when they have to	Building better roads will hello y regulate traffic and also that shouldn't be allowed to park in the platforms.	No, most people don't care about others on the road. They don't follow the rules properly
6	Auto rickshaw driver	45	F	Yes, in my opinion pedestrians have rights over platforms, they should be able to walk freely.	Yes	Before the stop line	No. Because, the platforms, where pedestrians walk are not properly maintained, two wheelers sometimes drive on the platforms.	Provide separate parking space so that vehicles don't park in the platforms.	No. They drive very rash and pedestrians are usually not even able to cross the roads.
7	Auto rickshaw driver	57	M	Everyone has been allotted space to use the road. If you take auto or bike, there is a white line on the road for them. Cars and bigger vehicles in the middle of the road. Footpath for pedestrians but who is using the given space. No one can be blamed	Yes. They are walking tirelessly in the sun and we at least are sitting under a roof	No one stops on the line unless police is there	No one is safe	People have to be conscious. Government brings new bus, metro and all. Implementing is government's duty but safely using this is in people's hands`	Everyone stops when people are crossing, if one or two cars don't stop, the following vehicles stop
8	Auto rickshaw driver	60	M	Of course. They also need space on the road to walk.	Yes	Before the stop line	No. People drive rashly and pedestrians don't take care.	Widen the roads	No. But pedestrian should also be careful and not just cross anywhere without checking

Number	Road User	Age	Gender (M/F)	Do pedestrians have any rights on the road?	Do vehicles have to stop for pedestrians?	At intersections / traffic lights, where should vehicles stop?	Do you feel pedestrians are safe in Chennai?	What needs to be done to make Chennai's roads safer for pedestrians?	Do you feel people driving (cars, bikes, buses etc) are considerate towards pedestrians?
9	Car driver	40	M	Yes, they should be free to walk without any difficulty.	Yes.	Before the stop line	No. The roads are very bad, it's very difficult to walk on them and many vehicle drivers don't drive according to the rules.	The roads should be developed so that it's big enough for even pedestrians to walk on them.	I am considerate, I can't speak for others. Pedestrians who walk on these roads suffer a lot, so I do as much as I can to stop when people are walking.
10	Car driver	63	M	Yes, they should be able to walk safely and without getting hurt	Yes	Before the stop line	No. I don't think pedestrians feel safe because these days vehicle drivers are in hurry and therefore are not considerate towards pedestrians	Better patrolling should be done and if someone doesn't follow traffic rules they should be punished.	No, as previously said, vehicle drivers don't care about the people on the road.
11	Car driver	41	F	Yes. They have the same right to use the roads safely as anyone else	Yes	Before the stop line where it is visible; and in line with the median where there is no stop line	No. Drivers do not slow down or stop for pedestrians. In fact they speed up when they see a pedestrian crossing	Need to redesign our roads to make it safe for everyone – wider footpaths, cycle lanes; force people to drive slowly. Ideally encourage people to use sustainable transport instead of their vehicles	Not at all. As I said people speed up on seeing a pedestrian. Parking on footpaths is very common so pedestrian are forced to step into the road. People also claim the footpath outside their houses as personal space for parking or for a garden!
12	Car driver	73	F	Yes. Same as everyone	Yes	Behind the stop line	No. I have given up walking almost because it is so hard. Hardly any footpaths, if its there, then it has garbage, vehicles, shops so then you have to walk on the road with the cars and buses	Need proper footpaths which are clean, with slopes to access them, well lit, and not encroached. If footpaths were like that, pedestrian would prefer to use it and avoid conflict with cars. Also need more pedestrian crossings.	No. No one stops for pedestrian. If I stop, I will get hit by the car behind as he doesn't expect me to stop for a pedestrian. It is hard to stop even if I want to!
13	Car driver	37	F	Yes, they have all the right to walk on these roads	Yes	Before the stop line	No. Because, most people who drive on the road are very careless. Pedestrians might get into an accident.	The roads should be widened and proper footpaths should be laid down.	A few people are, but most aren't considerate. They are very self centered and don't care for the other people on the road.

Number	Road User	Age	Gender (M/F)	Do pedestrians have any rights on the road?	Do vehicles have to stop for pedestrians?	At intersections / traffic lights, where should vehicles stop?	Do you feel pedestrians are safe in Chennai?	What needs to be done to make Chennai's roads safer for pedestrians?	Do you feel people driving (cars, bikes, buses etc) are considerate towards pedestrians?
14	Car driver	31	M	Yes, they should have the right to freely use the roads without any harm	Yes	Before the zebra crossing	No. There are many incidents these days of pedestrians getting injured due to road accidents.	Traffic should be regulated and proper parking should be provided.	No, most of them drive however they want. They don't care about the people walking on the roads.
15	Car driver	68 & 63	M & F (couple)	What rights? No rights for pedestrian. We walk daily and use the car. People drive so rashly without following rules. Pedestrians suffer	Yes	Before the line. Line has to be painted in most places.	Not at all. Vehicles don't stop it is so hard to cross the road. In other countries they have space allocated for pedestrians and cyclists	We need a new road system. Instead of trying to copy Singapore here in T. Nagar, they could have built new flyover or parking space or signals for people to walk. They should fine vehicles if they don't stop for pedestrians	I keep in mind but that doesn't mean everyone does. I would say they are not considerate enough
16	Two-wheeler rider	26	M	Yes, they have the right to walk, freely, without any fear	Yes	Anywhere before the stop line	No. Because of the way traffic moves in this city. It's very unregulated and if you're a pedestrian, there are chances you might get hurt.	The first problem that has to be address is that traffic should be regulated and more police patrolling.	No, as I said, they drive however they want. They don't care about anyone on the road.
17	Two-wheeler rider	30	F	Yes, they should be able to walk without fear	Yes absolutely	I always make a conscious effort to stop before the zebra crossing/ stop line	No. They are not safe because the conditions of the roads are bad. They are too thin for both vehicles and pedestrians to go in. They might end up hurting themselves	Build better roads, bring more stringent regulations.	Some people are considerate, not all. People who have the right educating and awareness are considerate.

Number	Road User	Age	Gender (M/F)	Do pedestrians have any rights on the road?	Do vehicles have to stop for pedestrians?	At intersections / traffic lights, where should vehicles stop?	Do you feel pedestrians are safe in Chennai?	What needs to be done to make Chennai's roads safer for pedestrians?	Do you feel people driving (cars, bikes, buses etc) are considerate towards pedestrians?
18	Two-wheeler rider	22	F	Yes, they have the right to walk freely and safely on the roads.	Yes.	I make sure to stop before the stop line.	No. There's no way pedestrians feel safe. The roads are very bad and are encroached upon by shops. The roads are not even and there are chances of getting hurt.	The roads should be built better. The people who sell on platforms should be given alternate location so that the roads can be expanded.	Not at all. I live here and I see vehicle drivers don't care about the people walking. They drive however they want.
19	Two-wheeler rider	28	M	No, they don't have any rights on the road, but they have to right to be about to walk easily on the roads.	Yes	Before the crossing line	No. Pedestrians are not able to walk safely. The condition of the roads is very bad. There is no proper parking space so vehicles are everywhere.	The roads should be improved and for pedestrians, platforms/ footpaths should be developed.	Yes, most people are considerate. They stop when people are crossing and the number of two wheelers who driver on footpaths have gone down.
20	Two-wheeler rider	34	M	Not on the roads, but yes, they should have the right to really freely on platforms.	Yes	Stop whenever others stop	Yes. Because the footpaths are clean and easy to walk	I don't know	Some people who follow traffic rules are considerate. Others aren't.
21	Two-wheeler rider	24	F	Yes, they should be able to walk freely without any fear.	Yes	Before the zebra crossing area	No. They don't feel safe because of the way people drive. They go very fast and they don't obey any of the traffic rules.	Traffic should be regulated. The gap between the bollards should be reduced so that no two wheeler can drive on platforms.	No, as said before, vehicle drivers don't obey traffic rules. They always speed.
22	Two-wheeler rider	24	M	No. They walk as they like. No one thinks about if any vehicle is coming 3or going. They feel they own the road	Not necessary. But I stop when old people are crossing	No one stops before the line. No one stops for the signal if police aren't around	No they are not. They don't walk where they are supposed to. Suddenly they will cross without understanding the speed of vehicles	Police/volunteers should stand for guiding people to stand	As I told before, I stop for elderly people. I don't think so otherwise

Number	Road User	Age	Gender (M/F)	Do pedestrians have any rights on the road?	Do vehicles have to stop for pedestrians?	At intersections / traffic lights, where should vehicles stop?	Do you feel pedestrians are safe in Chennai?	What needs to be done to make Chennai's roads safer for pedestrians?	Do you feel people driving (cars, bikes, buses etc) are considerate towards pedestrians?
23	Bus driver	50	M	No. They don't have any particular rights	We have to stop for pedestrians before zebra crossings	before the stop line	It's not so bad. Not many accidents involve pedestrians	There is a lot of encroachment on the footpaths	Well I don't think it's an issue. Pedestrians need to cross at zebra crossings and not just anywhere
24	Bus driver	44	M	No	Yes at signals but in general one should be careful as people often cross at random places	Behind the stop line or the centre median if there is no stop line	Its not very safe. People come in all directions. We (bus drivers) have to be careful when we are driving.	We need more signals and speed breakers. Footpaths also are not enough.	People do stop. You don't have a choice. You can hardly run a person down.
25	Bus driver	48	M	(He wasn't sure what rights pedestrians would have on the road)	We should give way to pedestrians even if it's not a pedestrian crossing	The law says behind the stop line	Generally pedestrians are safe.	Pedestrians should not walk on the road and should go on the footpath	Yes. People stop for pedestrians in general. Especially if it is an older person, I stop.
26	Bus driver	52	M	No	Well, I stop for pedestrians but pedestrians don't check and wait for traffic to clear. They should also walk on the side of the road.	Behind the stop line	It's reasonably safe. As I said, pedestrians need to walk on the footpath and not wander on the road.	Nothing in particular	Generally people are. We stop for pedestrians but of course you get drunkards driving and they behave badly. Pedestrians have to watch out for such people.

Table 5. Perception of pedestrians on pedestrian safety

Site Number	Age	Gender (M/F)	How often do you walk on the roads?	As a pedestrian, do you feel safe walking in Chennai?	What are the problems faced by you while walking?
1	16	F	2-4 times a week	No. The roads are always crowded and during peak hours there are vehicles going in all directions. As a pedestrian, it's scary	Vehicles move in unpredictable ways. They don't stop even when there are pedestrians on the road. The main problem in this street (where I live) is that it's too narrow
2	45	M	Once a week	No. The people who drive always speed and they drive rashly. It's very scary as a pedestrian to walk the streets.	I've always found it hard to walk in this street. I mostly walk here as I live here but the problem is that the road is very narrow.
3	45	F	Daily	Yes.	The only problem is the condition of the roads. The platforms are in a very bad condition.
4	55	M	Daily	No. The roads are not in good condition. It's very easy to get hurt especially for old people.	The platforms are non existent. There are shops all over the road and it's always cramped.
5	39	F	2-4 times a week	No. The roads are always crowded and it's difficult to walk as there are shops everywhere.	I can't even walk properly on these roads. There's garbage everywhere.
6	41	F	Daily	Yes.	I don't face much problem. The only inconvenience is that two wheelers often drive on the platforms.
7	17	M	Daily	No. On footpaths, all vehicles park and two wheelers even drive. Moreover, vehicles don't stop at traffic signals.	While walking to school, it's very difficult to cross as no one obeys traffic rules. It's also difficult to walk on platforms.
8	54	M	Daily	Yes.	Vehicles parking on footpaths. Otherwise, I think we should just adjust. I've lived all my life in Chennai, so I always adjust while walking
9	36	F	Daily	No. There are no footpaths anywhere. There are road side shops and TASMACs (government alcohol retail shops) taking over the platforms. I was residing in Singapore and Indian roads seem pathetic compared to it.	The footpaths are not even, there's a possibility of hurting yourself. Two wheelers either park or drive on the footpaths, preventing pedestrians from using it.
10	41	F	Daily	No. Most of the time I have to walk on the road with all the traffic honking at me and speeding by. It is very scary. Crossing the road many times I have to run.	So many things! No footpaths. If there is a footpath then it has garbage, vehicles and shops so it amounts to same thing. Hardly any pedestrian crossings with or without lights. They keep building overbridges and subways but it is not fair to make a pedestrian climb up and down in this heat. How can older people or disabled people manage?
11	64	F	Daily	No. People drive like crazy. It is very scary. I keep my walking to my area but that is bad enough. Even going to the nearby shop is difficult	Footpaths are uneven and there are so many obstacles on it. At my age it is tough to keep stepping up and down between the footpath and road. So much pollution also from vehicles – noise and dust.

Examining the relationship between road safety outcomes and the built environment in Bogotá, Colombia

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Key Findings

- The presence of pedestrian bridges is associated with higher severity of crashes.
- Recent BRT corridors leads to a decrease in traffic fatalities and injuries.
- Population density has a negative association with severity of crashes.
- Crashes are more severe at night probably due to higher speeds.

Abstract

The study of the relationship between the built environment and road safety suggests that density and urban design features may be associated with traffic incidents. In this study, quantitative data analysis using generalized ordinal logit models, and linear and log-linear regressions was conducted to estimate the influence of the built environment on road safety in Bogotá, focusing on road crash outcomes by estimating the influence of built environment attributes on fatalities and injured victims. The analysis was performed using georeferenced road crash data from 2012 to 2016 provided by Bogotá's Department of Mobility. The quantitative data analysis focused on arterial roads, considering crash severity and types of road users involved, as well as Bus Rapid Transit System corridors. This analysis was complemented with on-site interviews. The results suggest that the presence of pedestrian bridges is positively associated with the number of road crashes for all road users. Other urban variables such as density and distance to intersections showed significant correlations with safety.

Keywords

Built environment, road safety, BRT, road crashes, infrastructure, pedestrian bridges

Introduction

The study of the relationship between the built environment and road safety implies several challenges from an urban planning perspective, particularly in areas with compact urban form and high densities where multiple road users interact. Cities promoting and investing in sustainable mobility, such as public transport, walking and bicycling, and encouraging compact and mixed-use urban forms, face the task of attracting more road users around busy areas. This in turn increases the probability of crashes taking place unless road safety countermeasures are implemented. Certain urban design features such as the provision of infrastructure, traffic-calming measures, traffic lights and enhanced transit stations can help to attract road users. In this order of ideas, in this paper such information is used to examine the influence of built environment attributes on road crash data in Bogotá (Colombia) relating to the 2012 – 2016 period.

Bogotá is well known globally for the progress it has made in the promotion of sustainable transport, including the implementation of a Bus Rapid Transit (BRT) system and the provision of walking and bicycling infrastructure. Despite this, however, Bogotá still recorded a considerable number of road crash fatalities and injuries after a period of significant progress between 1996 and 2006 (Vergel-Tovar, Hidalgo, & Sharpin, 2018). In addition to policy, regulation, and enforcement measures, pedestrian bridges, traffic lights, and enhanced crosswalks have been implemented in order to improve road safety for pedestrians. Despite these efforts, 49% of the traffic fatalities in 2007 were pedestrians (Alcaldía Mayor de Bogotá, 2017). This is partially due to the fact that Bogotá –as many other cities- was planned as a car-centric model before the implementation of the BRT and walking and bicycling infrastructure at the end of the twentieth century (Quiñones, Pardo, Moscoso, Sánchez, López, & López, 2017).

We use three types of quantitative data analyses. First, we examine the influence of the built environment on road safety with data from segments between two intersections of arterial roads as each observation. Second, we examine how the built environment influences road crashes by road users.

Lastly, we examine arterial corridors by comparing the corridors with BRT trunk lines and the ones without them.

This paper is structured in six parts, which include: The Literature Review with a description of previous road safety studies by road user types for different regions globally; the Methodology which describes the study area, the data used, the data processing, and the methods used for the three analyses; the Results section which describes each type of analysis; and, finally, the study's Discussion and Conclusions.

Literature Review

Road safety and the built environment

Road safety is a public health issue across different countries with significant interest in the influence of city design on road crashes. The built environment, as a result of urban space design, plays an important role on road user behavior and on the probability of road traffic injuries and fatalities (Elvik, Høye, Vaa, & Sørensen, 2009).

From an urban planning perspective, context matters in terms of how the built environment influences road safety. According to the analysis of built environment attributes and their influence on road safety, the results suggest that dense urban areas tend to be safer as speeds are relatively low, and compounded with design features such as narrow lanes and traffic calming measures. These measures significantly improve road safety performance in relation to more conventional road designs (Ewing, & Dumbaugh, 2009). In addition to the role of density and urban design features, a number of studies have analyzed the influence of built environment attributes on road safety. In Montreal (Canada), studies on this influence have found that measures that promote dense and compact urban forms associated with sustainable transport modes, such as the mixture of land uses and transit supply, increase pedestrian activity and attract road users who might be at risk if road safety strategies were not included in the design of the built environment (Miranda-Moreno, Morency, & El-Geneidy, 2011).

Studies analyzing the influence of the built environment on road safety reveal mixed results. One study conducted with crash data from San Antonio-Bexar County (Texas, USA) found that four-lane intersections and commercial land uses associated with the presence of big-box developments are positively associated with the number of road crashes (Dumbaugh, & Li, 2010). Mixed results were found in another study examining the influence of land use and road design on crash frequency in New York City, pointing to a lower probability of crashes in areas characterized by industrial, commercial, and open land uses, but a higher probability of pedestrian-vehicle collisions in locations with more lanes, greater road width, and a higher concentration of schools and transit stops (Ukkusuri, Miranda-Moreno, Ramadurai, & Isa-Tavarez, 2012). A study of 24 cities in California on the effect of street design and network characteristics on crashes, found that denser street networks with higher intersection counts are negatively associated with the number of crashes and their severity. In contrast, additional traffic lanes and increased connectivity are positively associated with crashes (Marshall, & Garrick, 2011).

Several studies have also examined the use of pedestrian bridges in urban environments. It has been found that pedestrians are more likely to use these more often if time loss (Räsänen, Lajunen, Alticafarbay & Aydin, 2007) and the increased walking distance are not considerable. Thus, increased distance and time raise the likelihood of direct –at risk- crossing by pedestrians (Cantillo, Arellana, & Rolong, 2015) despite the fact that this infrastructure might appear to be safer (Rizati, Ishak, & Endut, 2013).

Thus, there are mixed results in terms of the role played by the built environment in road safety, and this complex set of outcomes must be carefully considered. This is especially true for busy areas with high attraction of road users, especially in those areas where mass transit and walking and bicycling infrastructure implies greater use volume and flow.

Road safety and Bus Rapid Transit (BRT)

Although the implementation BRT systems has rapidly evolved globally, the relationship between road safety and BRT is still unclear (Vecino-Ortiz, & Hyder, 2015; BRTData, 2019). BRT systems incorporate rail-based system features such as enhanced boarding stations and exclusive lanes segregated from the mixed traffic. These characteristics imply better infrastructure with the flexibility of a BRT system, and they improve system operations in terms of safety (Vecino-Ortiz, & Hyder, 2015). However, the influence of BRT on road safety is still being examined and the relationship between road-user fatalities and injury severity is, as yet, unknown.

Studies examining the influence of BRT on road safety in Melbourne (Australia) found a 15% road crash reduction (Goh, Currie, Sarvi & Logan, 2013), a second analysis for bus priority measures applied in Melbourne found a reduction of the proportion of road crashes as a result of improvements in the maneuverability of buses (Goh, Currie, Sarvi & Logan, 2014). Another analysis of road safety data in nine cities implementing BRT systems found road safety improvements in cities like Guadalajara (Mexico), and the positive influence of infrastructure and operational features such as center-lane systems on reducing road crashes (Duduta, Adriazola, Hidalgo, Lindau, & Jaffe, 2012).

An analysis of road safety and BRT in Bogotá suggests that there is an overall reduction of road crashes. However, an increase was found within the influence area of the busiest BRT stations and along the corridors where speed increments occurred as a result of fewer intersections and traffic lights, as well as infrastructure improvements for mixed traffic along BRT corridors (Bocarejo, Velasquez, Díaz, & Tafur, 2012). An ex-post evaluation found a significant reduction in road crash injuries and fatalities as a result of the implementation of Phases 1 and 2 of the BRT system between 1998 and 2006 (Hidalgo, Pereira, Estupiñán, & Jiménez, 2013).

Despite the emerging evidence of the relationship between BRT and road safety, there is still a gap in terms of the influence of BRT on the type of road users involved in road crashes as well as on the severity level of these collisions in terms of injuries and fatalities. Little is also known about the influence of built environment features such as pedestrian bridges on road safety.

Methodology

Study Area

Bogotá is the capital of Colombia and its largest city with a population of 7,980,001 inhabitants. Its urban area measures 37,945.23 hectares and, according to the Urban Master Plan, there are 2,973.93 hectares reserved for urban expansion (Alcaldía Mayor de Bogotá, 2017a). The city has 15,400 km of road lanes, 472 km of bike paths, and there are 9 BRT trunk corridors measuring a total length of 114 km (Alcaldía Mayor de Bogotá, 2017b). The mode share of daily trips in Bogotá includes 21% pedestrian trips, 27% in conventional and integrated buses, 18% of trips on BRT, 13% in private vehicles, 5.5% on motorcycles, 4.5% on bicycles, and 5.5% in taxis. On a daily basis, approximately 15 million trips are made within the city, while more than 188,000 vehicles commute to Bogotá from neighboring municipalities (Alcaldía Mayor de Bogotá, 2017b; Secretaría Distrital de Movilidad, 2015).

Data

The data set used includes georeferenced road crashes from 2012 to 2016 (Secretaría Distrital de Movilidad, 2017). The traffic crashes analyzed are divided into three different levels of severity according to the most severe injury experienced in the crash: fatality, injury (non-fatality), and damage-only (no injury). The dataset also provided information about crash type (multi-vehicle crashes, run over (pedestrian involved), risk of the passenger falling, and overturn) and time of day. The built environment data for BRT and arterial roads was provided by Bogotá's City Planning Department (Alcaldía Mayor de Bogotá, 2018).

The built environment features selected as independent variables were determined based on previous studies in terms of urban design characteristics such as number of lanes and connectivity, land uses within the influence area at parcel level, presence of pedestrian bridges, estimation of population density at block level, identifying and counting the number of intersections and number of blocks within the study area, and average speed for motorized vehicles. The frequency of crashes was considered in geographical terms as the number of crashes within the study area (arterial roads buffer and BRT corridors data). All the data was processed using geographic information systems.

Data processing

Arterial roads data

The road crash data was processed using the ArcGIS software for GIS. First, road crashes along main arterial roads were identified by taking a buffer of 70 meters along major arterials in the city (Figure 1 in the Annex), using the routes classified as V1 and V0 in accordance with the Urban Master Plan for Bogotá. Road classification in the city depends entirely on road width; V1 and V0 are 60 meters and 100 meters wide respectively, which results in 79 official arterial roads generated by 531 polylines. Built environment features such as blocks, land uses, traffic lights, and presence of pedestrian bridges were also identified within the polygons determined by a 70-meter buffer area from arterial roads in order to include blocks and their urban attributes in the analysis, excluding intersections between major arterial roads to avoid double counting (Figure 2 in the Annex).

BRT corridors data

The traffic crash data was processed by identifying road collisions along treatment corridors (BRT) and control corridors (main arterial roads) as shown in Figure 1c in the Annex. The data was then processed identifying road collisions within a 70-meter buffer area. The built environment attributes were identified intersecting the parcels, blocks, intersections, pedestrian bridges, and traffic lights within the buffer area.

Methods

Data analysis 1

The first phase of data analysis ran a generalized ordinal logistic regression model taking the severity level of the crash as the dependent variable. The ordinal dependent variable was road crash outcome: i) damage-only (no injury) =3; ii) injured victim (non-fatality) =2; and, iii) fatal victim=1. This structure assumes that the highest severity outcome is a fatal victim. The independent variables included in the model are described in Table 1. The probabilities estimated for the dependent variable in the generalized ordinal logistic regression models for data analyses 1 and 3 are based on the following equations (Williams, 2006):

$$P(Y_i = 1) = 1 - g(X_i\beta_1)$$

$$P(Y_i = j) = g(X_i\beta_j - 1) - g(X_i\beta_1)\; j = 3, \ldots., M-1$$

$$P(Y_i = M) = g(X_i\beta_m - 1) \quad (1)$$

Data analysis 2

The second phase of data analysis hypothesizes the number of road crashes with casualties per mode in each polygon as the dependent variables, with built environment attributes as the independent variables. Table 2 describes the built environment attributes included in the linear regression models. The units of observations are each of the polygons shown in Figure 2 in the Annex.

Data analysis 3

The third data analysis runs a generalized ordinal logistic regression model also using severity level as the dependent variable. The ordinal dependent variable is structured in the same way as in Data analysis 1. This model includes binary explanatory variables for the BRT corridors studied in order to determine the probabilities of reaching each potential outcome for each phase of the system. The generalized ordinal logistic regression model allowed a comparison of the three different outcomes by running the GOLOGIT2 command on STATA (Williams, 2005, 2006). The independent variables included in the model are described in Table 3. The estimated probabilities for the dependent variable are estimated with the same equations described for the data analysis.

Table 1. Descriptive statistics, severity level (damage-only=3, injured victims=2 and fatal victims=1) and independent variables (N=12,312). Model 1.

Variables	Definition	Mean	St. Dev.	Min	Max
Dependent variable					
Severity level (ordinal variable)					
Fatal victim (level 1)	Road crash outcome is a fatal victim	0.018	0.132	0.00	1.00
Injured victim (level 2)	Road crash outcome is an injured victim	0.283	0.450	0.00	1.00
Damage-only (level 3)	Road crash outcome is damage-only	0.699	0.459	0.00	1.00
Independent variables					
Crash type					
Multi-vehicle crashes	If multi-vehicle crash=1; otherwise=0	0.860	0.347	0.00	1.00
Run over (pedestrian involved)	If run over=1; otherwise=0	0.093	0.290	0.00	1.00
Passenger falling	If passenger falling=1; otherwise=0	0.025	0.156	0.00	1.00
Overturn	If overturn=1; otherwise=0	0.010	0.099	0.00	1.00
Other (fire, self-damage, other)	If other type=1; otherwise=0	0.012	0.109	0.00	1.00
Time of day					
Range 1 (between 00:00 and 02:59 hours)	If crash occurred in range 1=1; otherwise=0	0.031	0.173	0.00	1.00
Range 2 (between 03:00 and 05:59 hours)	If crash occurred in range 2=1; otherwise=0	0.058	0.234	0.00	1.00
Range 3 (between 06:00 and 08:59 hours)	If crash occurred in range 3=1; otherwise=0	0.177	0.382	0.00	1.00
Range 4 (between 09:00 and 11:59 hours)	If crash occurred in range 4=1; otherwise=0	0.162	0.368	0.00	1.00
Range 5 (between 12:00 and 14:59 hours)	If crash occurred in range 5=1; otherwise=0	0.183	0.386	0.00	1.00
Range 6 (between 15:00 and 17:59 hours)	If crash occurred in range 6=1; otherwise=0	0.166	0.372	0.00	1.00
Range 7 (between 18:00 and 20:59 hours)	If crash occurred in range 7=1; otherwise=0	0.145	0.352	0.00	1.00
Range 8 (between 21:00 and 23:59 hours)	If crash occurred in range 8=1; otherwise=0	0.078	0.269	0.00	1.00
Land uses					
Proportion of parcels with residential uses	Proportion of parcels with residential uses within buffer area	0.357	0.216	0.00	0.87
Proportion of parcels with industrial uses	Proportion of parcels with industrial uses within buffer area	0.024	0.051	0.00	0.20
Proportion of parcels with commercial uses	Proportion of parcels with commercial uses within buffer area	0.286	0.220	0.00	0.73
Proportion of parcels with institutional uses	Proportion of parcels with institutional uses within buffer area	0.056	0.102	0.00	0.40
Proportion of parcels with other uses	Proportion of parcels with other uses within buffer area	0.074	0.095	0.00	0.29
Proportion of parcels with public space uses	Proportion of parcels with public space uses within buffer area	0.133	0.131	0.00	0.44
Pedestrian bridges					

Variables	Definition	Mean	St. Dev.	Min	Max
Distance to the closest pedestrian bridge	Linear distance in meters from crash to the closest pedestrian bridge	419.681	324.466	3.79	1835.56
Number of pedestrian bridges (within polygon)	# pedestrian bridges within the buffer area	1.823	1.625	1.00	6.00
Pedestrian bridge length in meters	Average length of pedestrian bridges within buffer area	216.512	153.002	29.36	783.71
Density, intersections and average speed					
Population density at the polygon level	Density of people per hectare within buffer area	100.308	66.593	12.03	400.44
Number of blocks (within polygon)	# blocks within buffer area	43.957	30.863	14.00	124.00
Distance to the closest intersection	Linear distance from collision to the closest intersection in meters	548.192	367.204	0.23	1683.63
Number of intersections (within polygon)	# intersections within buffer area	1.212	1.898	0.00	6.00
Average speed	Average speed of motorized vehicles within buffer area	30.816	9.244	5.42	45.11
Road attributes					
Lane width		3.335	0.228	2.86	3.92
Road section (between sidewalk borders)		36.778	10.537	17.21	83.83
Total number of carriageways		2.733	0.926	2.00	4.00
Road length		2072.380	1124.701	549.00	4500.00
Total number of lanes		5.715	1.623	1.00	8.00

Table 2. Descriptive statistics dependent and independent variables per vulnerable road user involved (N=216) Model 2

Variables	Definition	Mean	St. Dev.	Min	Max
Dependent variable					
Number of road crashes involving a motorcyclist casualty	# crashes involving motorcyclists casualties normalized by buffer length	29.33	31.01.	0	211
Number of road crashes involving a cyclist casualty	# crashes involving cyclists casualties normalized by buffer length	8.71	11.98	0	106
Number of road crashes involving a pedestrians casualty	# crashes involving pedestrians casualties normalized by buffer length	26.63	29.32	0	175
Independent variables					
Population density	Average population by buffer area	134.6	100.8	0	587.2
Urban Design					
Number of blocks	Average number of blocks within the buffer length	31.29	83.45	2.149	1,508
Lane width	Width of lanes in meters	2.23	0.31	2.54	4.42
Section width	Width of section between sidewalks	603.8	451.0	38.31	2,836
Number of lanes	Total number of lanes in the section of each polygon	5.68	2.03	2	12
Pedestrian bridges	Number of pedestrian bridges	0.60	1.08	0	9
Traffic lights	Number of traffic lights in the polygon	498.8	441.1	18.22	4,496
Land Uses					
Mixticity	Ratio between the combination of the proportions of residential land use and non-residential land use within the polygon, and 0.25 (scenario where residential and non-residential proportions are the same)	0.704	0.304	0	1

Table 3. Descriptive statistics. (N=49,408) Model 3.

Variables	Definition	Mean	Std. Dev.	Min	Max
Dependent variable					
Severity level (ordinal variable)					
Fatal victim (level 1)	Road crash outcome is a fatal victim	0.014	0.117	0.00	1.00
Injured victim (level 2)	Road crash outcome is an injured victim	0.285	0.451	0.00	1.00
Damage-only (level 3)	Road crash outcome is damage-only	0.702	0.458	0.00	1.00
Independent variables					
Crash type					

Variables	Definition	Mean	Std. Dev.	Min	Max
Crashes	If crash=1; otherwise=0	0.853	0.354	0.00	1.00
Run over (pedestrian involved)	If runover=1; otherwise=0	0.101	0.301	0.00	1.00
Passenger falling	If passenger falling=1; otherwise=0	0.024	0.153	0.00	1.00
Overturn	If overturn=1; otherwise=0	0.009	0.097	0.00	1.00
Other (fire, self-damage, other)	If other type=1; otherwise=0	0.013	0.113	0.00	1.00
Time of day					
Range 1 (between 00:00 and 02:59 hours)	If crash occurred in range 1=1; otherwise=0	0.029	0.168	0.00	1.00
Range 2 (between 03:00 and 05:59 hours)	If crash occurred in range 2=1; otherwise=0	0.051	0.220	0.00	1.00
Range 3 (between 06:00 and 08:59 hours)	If crash occurred in range 3=1; otherwise=0	0.168	0.374	0.00	1.00
Range 4 (between 09:00 and 11:59 hours)	If crash occurred in range 4=1; otherwise=0	0.167	0.373	0.00	1.00
Range 5 (between 12:00 and 14:59 hours)	If crash occurred in range 5=1; otherwise=0	0.187	0.390	0.00	1.00
Range 6 (between 15:00 and 17:59 hours)	If crash occurred in range 6=1; otherwise=0	0.166	0.372	0.00	1.00
Range 7 (between 18:00 and 20:59 hours)	If crash occurred in range 7=1; otherwise=0	0.150	0.357	0.00	1.00
Range 8 (between 21:00 and 23:59 hours)	If crash occurred in range 8=1; otherwise=0	0.081	0.273	0.00	1.00
Pedestrian bridges					
Distance to the closest pedestrian bridge	Linear distance in meters from collision to the closest pedestrian bridge	753.312	623.344	1.42	3168.90
Number of pedestrian bridges (within polygon)	# pedestrian bridges within buffer area	3.207	3.507	0.00	15.00
Density, intersections and average speed					
Population density at the polygon level	Density of people per hectare within buffer area	128.980	79.843	1.475	476.53
Number of blocks (within polygon)	# blocks within buffer area	132.730	81.466	19.00	389.00
Number of intersections (within polygon)	# intersections within buffer area	2.516	4.221	0.00	18.00
Average speed	Average speed of motorized vehicles within buffer area	11.936	7.820	1.68	36.68
BRT					
Distance to BRT station	Linear distance in meters from collision to the closest BRT station	841.661	772.962	109.62	2912.96
BRT corridors phase one	Crash occurred within a BRT corridor (phase one)	0.178	0.382	0.00	1.00
BRT corridors phase two	Crash occurred within a BRT corridor (phase two)	0.196	0.397	0.00	1.00
BRT corridors phase three	Crash occurred within a BRT corridor (phase three)	0.084	0.278	0.00	1.00

Results

Data analysis 1: Arterial roads

Results are shown in Table 4. The probabilities of involvement in a fatal crash are higher when the type of crash is a multi-vehicle crash or when a passenger falls out, than they are when the accident involves running someone over. The probabilities of causing injury are higher when the type of collisions are multi-vehicle crashes, overturn, or other. In terms of the time of day, road crashes taking place between noon and 6.00 pm show the highest probabilities of resulting in fatalities, with similar results for injured victims. Commercial and institutional land uses within the buffer area show negative associations with fatal and injured victims while residential use shows positive association with injuries. This suggests that particular attention should be paid to road safety measures in residential areas. The distance to pedestrian bridges is negatively associated with fatal victims compared to crashes with injuries or property damage-only, suggesting that the severity of road crashes increases around pedestrian bridges. Similarly, the number of pedestrian bridges in the buffer area increases the probability of causing fatalities and injury to victims. A higher number of intersections within the buffer area decreases the likelihood of there being fatal victims and increases the probability of injury or damages only outcomes for road crashes in the study area. The width of lanes and the number of carriageways are positively associated with the probability of causing injury to victims.

Data analysis 2: Crashes per type of vulnerable road user

Results are shown in Table 5. Crashes involving all types of vulnerable road users have a positive correlation with population density in the polygon, the presence of pedestrian bridges and traffic lights. The marginal effect of pedestrian bridges is higher for motorcyclist casualties. Similarly, Model 1 shows a negative association between mixed land use and the number of pedestrian casualties. Model 2 shows a negative association between the number of blocks per kilometer and the number of cyclist casualties. Model 3 shows that the number of lanes is positively correlated with the number of motorcyclist casualties.

Data analysis 3: BRT corridors

Regarding the type of road crash, the results suggest that multi-vehicle crashes increase the probability of there being fatal victims as well as that of the passenger falling and other crash types (Table 6). The overturn crash type increases the probability of injuries and fatalities. Regarding the time of day, off-peak hours increase the probability of road crash fatalities, and the results for panel 2 suggest that the probability of injuries is higher during peak hours as is the probability of fatal victims.

Results for pedestrian bridges suggest that the likelihood of injured victims and damage-only crashes is higher in close proximity to pedestrian bridges in the study area. Results for the number of pedestrian bridges suggest that the greater the number of such bridges, the greater the likelihood of road crash injuries and fatalities. However, similarly to the results obtained in Data analysis 1, this positive association should be taken with caution. In the Conclusion section, we describe a number of factors explaining these results. A higher population density suggests a lower likelihood of injured victims and thus a higher probability of the occurrence of damage-only crashes in the study area.

The number of blocks increases the likelihood of injuries and fatalities, but a higher number of intersections implies a lower probability of there being injured victims and thus increases the probability of there being damage-only crashes. A higher average speed increases both the likelihood of injury being caused to a victim, and the probability of a road crash fatality. Larger block sizes within the study area suggest a higher probability of road crash fatalities.

In terms of the BRT, the results suggest that the likelihood of a fatality diminishes when the crash takes place near BRT stations. Crashes taking place along BRT corridors in Phase 2 are less likely to result in fatalities and injuries, and road crashes taking place along BRT corridors in Phase 3 are less likely to result in injuries, meaning that there is a higher probability of there being damage-only crashes in these corridors.

Table 4. Generalized ordered logit model results, severity level (damage-only=3, injured victims=2 and fatal victims=1)

	Panel 1 **Severity level=1 (Fatal victim)** *In relation to levels 2 and 3*		**Panel 2** **Severity level=2 (Injured victim)** *In relation to levels 1 and 3*	
	Estimated coefficients	**Standard errors**	**Estimated coefficients**	**Standard errors**
Crash type				
(reference: Run over: pedestrian involved)				
Multi-vehicle Crashes	2.1232 ***	(0.1527)	8.4488 ***	(1.0011)
Passenger falling	2.4135 ***	(0.7213)	-13.5872	(1490.3467)
Overturn	0.1164	(0.3594)	5.3918 ***	(1.0324)
Other (fire, self-damage, other)	18.3236	(2746.5435)	3.9997 ***	(1.0655)
Time of day				
(reference: between 00:00 and 02:59 hours)				
Range 2 (between 03:00 and 05:59 hours)	-0.0504	(0.2992)	0.2043	(0.1535)
Range 3 (between 06:00 and 08:59 hours)	0.8885 **	(0.3015)	0.3768 **	(0.1351)
Range 4 (between 09:00 and 11:59 hours)	0.7253 *	(0.3106)	0.9131 ***	(0.1397)
Range 5 (between 12:00 and 14:59 hours)	1.2878 ***	(0.3294)	1.1012 ***	(0.1397)
Range 6 (between 15:00 and 17:59 hours)	1.2484 ***	(0.3337)	0.8075 ***	(0.1384)
Range 7 (between 18:00 and 20:59 hours)	0.6044 *	(0.2973)	0.6316 ***	(0.1392)
Range 8 (between 21:00 and 23:59 hours)	0.9071 **	(0.3312)	0.3284 *	(0.1486)
Land uses				
Proportion of parcels with residential uses	-0.3804	(1.5065)	1.4099 **	(0.4408)
Proportion of parcels with industrial uses	2.4190	(2.7694)	2.2290 *	(0.8916)
Proportion of parcels with commercial uses	-1.1182	(1.3855)	-0.0973 ***	(0.3929)
Proportion of parcels with institutional uses	-4.6358 **	(1.7355)	-1.8935 ***	(0.5388)
Proportion of parcels with other uses	-3.9955	(2.7688)	1.4861 *	(0.7239)
Proportion of parcels with public space uses	-1.5276	(1.1860)	-0.6216	(0.4180)
Pedestrian bridges				
Distance to the closest pedestrian bridge	-0.0006 *	(0.0002)	-0.0001	(0.0001)
Number of pedestrian bridges within buffer area	0.4279 **	(0.1633)	0.2573***	(0.0514)
Pedestrian bridge length in meters	-0.0007	(0.0005)	0.0001	(0.0002)
Density, intersections and average speed				
Population density within buffer area	-0.0021 *	(0.0020)	0.0008	(0.0007)
Number of blocks within buffer area	-0.0144	(0.0101)	-0.0178 ***	(0.0031)
Distance to the closest intersection	-0.0001	(0.0003)	0.0001	(0.0001)
Number of intersections within buffer area	-0.5335 ***	(0.1364)	-0.3603 ***	(0.0391)
Average speed	-0.0033	(0.0115)	-0.0065	(0.0036)
Lane width	-0.3521	(0.3894)	0.4128 **	(0.1313)
Section width	-0.0041	(0.0188)	-0.0085	(0.0054)

	Panel 1 Severity level=1 (Fatal victim) *In relation to levels 2 and 3*		Panel 2 Severity level=2 (Injured victim) *In relation to levels 1 and 3*	
	Estimated coefficients	**Standard errors**	**Estimated coefficients**	**Standard errors**
Total number of carriageways	0.3347	(0.2259)	0.3212 ***	(0.0633)
Polygon length	0.0004	(0.0004)	0.0005 ***	(0.0001)
Number of lanes	0.0519	(0.0653)	-0.0322	(0.0196)
Constant term	3.5411 ***	(2.1094)	-10.0177 ***	(1.2311)
N			12312	
Log likelihood			-5802.4918	
LR chi2(50)			5099.69	
Prob > chi2			0.0000	
Pseudo R squared			0.3053	

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Table 5. Linear regression, number of vulnerable road users' casualties and built environment attributes

Variables	Model 1 Pedestrian casualties		Model 2 Cyclist casualties		Model 3 Motorcyclist casualties	
	Estimated coefficients	**Standard errors**	**Estimated coefficients**	**Standard errors**	**Estimated coefficients**	**Standard errors**
Lane width	-1.805	(5.110)	3.023	(1.887)	4.306	(5.073)
Section Width	0.0335	(0.129)	-0.0307	(0.0476)	0.0734	(0.128)
Number of lanes	0.982	(1.018)	0.580	(0.376)	2.171 **	(1.011)
Mixticity	-41.38 **	(20.84)	-8.942	(7.693)	-21.22	(20.69)
Blocks per km	0.0288	(0.163)	-0.182 ***	(0.0601)	-0.198	(0.162)
Population density	0.0414 ***	(0.00892)	0.0226 ***	(0.00329)	0.0428 ***	(0.00886)
Pedestrian bridges	4.903 ***	(1.807)	3.326 ***	(0.667)	8.986 ***	(1.794)
Traffic lights	7.432 ***	(0.914)	3.344 ***	(0.338)	8.281 ***	(0.908)
Constant	5.029	(18.11)	-11.94 *	(6.688)	-23.55	(17.98)
N	216		216		216	
R-squared	0.420		0.526		0.489	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6. Generalized ordered logit model results, severity level (damage-only=3, injured victims=2 and fatal victims=1) and BRT corridors

	Panel 1 Severity level=1 (Death victim) In relation to levels 2 and 3		Panel 2 Severity level=2 (Injured victim) In relation to levels 1 and 3	
	Estimated coefficients	**Standard errors**	**Estimated coefficients**	**Standard errors**
Crash type				
(reference: Run over: pedestrian involved)				
Multi-vehicle crashes	2.3793 ***	(0.0848)	9.9923 ***	(1.0002)
Passenger falling	1.8621 ***	(0.2964)	1.3262	(1.4146)
Overturn	0.1870	(0.1975)	6.5641 ***	(1.0103)
Other (fire, self-damage, other)	2.7528 ***	(0.5820)	5.9168 ***	(1.0117)
Time of day				
(reference: between 00:00 and 02:59 hours)				
Range 2 (between 03:00 and 05:59 hours)	0.0593	(0.1878)	0.0516	(0.0806)
Range 3 (between 06:00 and 08:59 hours)	0.8398 ***	(0.1798)	0.3176 ***	(0.0705)
Range 4 (between 09:00 and 11:59 hours)	1.0098 ***	(0.1887)	0.8784 ***	(0.0728)
Range 5 (between 12:00 and 14:59 hours)	1.0455 ***	(0.1859)	0.9263 ***	(0.0721)
Range 6 (between 15:00 and 17:59 hours)	1.0418 ***	(0.1867)	0.7159 ***	(0.0721)
Range 7 (between 18:00 and 20:59 hours)	0.7359 ***	(0.1750)	0.6760 ***	(0.0730)
Range 8 (between 21:00 and 23:59 hours)	0.2356	(0.1744)	0.0943	(0.0760)
Pedestrian bridges				
Distance to the closest pedestrian bridge	0.0000	(0.0001)	-0.0001 *	(0.0000)
Number of pedestrian bridges within buffer area	-0.0044	(0.0169)	0.0257 ***	(0.0052)
Density, intersections and average speed				
Population density within buffer area	-0.0005	(0.0008)	-0.0028 ***	(0.0003)
Number of blocks within buffer area	0.0017 *	(0.0007)	0.0008 ***	(0.0002)
Number of intersections within buffer area	0.0116	(0.0147)	-0.0196 ***	(0.0041)
Average speed	-0.0047	(0.0061)	0.0078 ***	(0.0020)
Average block size in sq. mt within buffer area	0.0001 **	(0.0000)	-0.0000	(0.0000)
BRT				
Distance to BRT station	-0.0004 ***	(0.0001)	0.0000	(0.0000)
BRT corridors phase one	0.0136	(0.1689)	0.0438	(0.0527)
BRT corridors phase two	-0.4322 **	(0.1458)	-0.2439 ***	(0.0483)
BRT corridors phase three	-0.1220	(0.1757)	-0.1935 **	(0.0592)
Constant term	1.8122 ***	(0.3136)	-8.8235 ***	(1.0065)
N			49408	
Log likelihood			-22229.689	
LR chi2(44)			21328.47	
Prob > chi2			0.0000	
Pseudo R squared			0.3242	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Discussion

The data analysis clearly shows that the multi-vehicle crash type increases the probabilities of road crash fatalities, as well as the fact that such crashes are more likely to occur during peak hours, presumably due to road users' higher risk of exposure during peak hours (Santos, Behrendt, Maconi, Shirvani & Teytelboym, 2010). The coefficients by hour demonstrate that crash severity increases at night given a reduced marginal effect of the time variable on injuries compared with peak hours, which is lower for fatal road crashes. This could be associated with higher speeds recorded at night in the entire arterial network (Hidalgo, López, Lleras, & Adriazola-Steil, 2018). The positive association of lane widths with crash severity can in turn be associated with a higher probability of filtering by motorcyclists (Peña Cabra, 2014), longer crossing distances for pedestrians, and higher speeds for all road users (Welle, Liu, Li, Adriazola-Steil, King, Sarmiento & Obelheiro, 2015).

The results of the models also show that the presence of pedestrian bridges is associated with an increase in the number and severity of road crashes for all road users. This association could be due to the fact that pedestrian bridges prioritize motor vehicles eliminating possible intersections, which increases vehicle speeds along the corridors, thus reducing safety for all road users (Welle at al., 2015).

To better understand these results, we conducted 7 visits to intersections with high and low crash levels and the presence of pedestrian bridges. After interviewing pedestrians and street vendors, who are frequent users and had spent several hours at the locations respectively, we found a number of explanations for the results obtained. First, participants pointed out the spatial mismatch between transit stops and pedestrian bridges. They preferred to cross the arterial roads at level because using the pedestrian bridge implied an increase in their travel time. Second, some of the pedestrian bridges situated in locations with a high number of road crashes are of a large scale and length, which tends to be a disincentive for potential users. Participants suggested that the length of the pedestrian bridge implied longer commutes when transferring between transit routes or when trying to reach a transit stop. Finally, participants mentioned personal safety as a main concern, as they often avoid pedestrian bridges due to the possibility of theft. These three factors could help to explain the results of the quantitative data analysis.

The results for the models for road users show a positive association between density and road safety which goes against the results found in the literature (Ewing & Dumbaugh, 2009), in this case, probably due to a higher exposure of vulnerable users. Results for all road users show a positive association between the presence of pedestrian bridges and the number of casualties. This could be associated with the fact that pedestrian bridges allow motorized traffic to get up to higher speeds (Dumbaugh & Li, 2010), which, in turn, is associated with a higher probability for crashes occurring and their severity (Hidalgo et al., 2018). Mixed land uses decrease the number of pedestrian casualties, as also mentioned in the literature (Welle et al., 2015). The number of lanes is only significant for motorcyclists, which can be explained by the filtering options and higher traffic speeds (Peña Cabra, 2014).

The use of pedestrian bridges to access BRT stations is a measure that increases speeds for all motorized users. Pedestrian bridges increase the risk for all road users even in BRT corridors. This is aligned with the literature as being the result of giving priority to motorized traffic in urban areas, which affects all road users, not only pedestrians (Welle et al., 2015).

The data analysis for BRT corridors also reflects that the most recent BRT corridors (Phases 2 and 3) are having an important effect on reducing the probabilities of road crash injuries and fatalities; however, the corridors in Phase 1 are no longer producing this positive effect. As the results for Phase 1 are not similar to the current literature (Bocarejo et al., 2012; Duduta, Adriazola-Steil, Wass, Hidalgo, Lindau, & John, 2015), further research is needed to understand the causes.

Conclusions

The results explored in the discussion section about the association of speed and the probability and severity of crashes highlight the importance of promoting speed management measures during peak hours, especially in areas where there are pedestrian bridges and where the number of crashes is high. Speed management measures should also be implemented in off peak hours in the locations with the highest concentration of crashes and the highest speeds recorded (Hidalgo et al., 2018).

Land use seems to have a significant impact on road safety outcomes. The mixture of the land uses variable, measured in the Data analysis 2, is an interesting association that could be further explored based on the data analysis relating to the buffer area of major arterial roads.

The presence of pedestrian bridges plays an important role in road safety and the future planning of major arterial roads. Intersections have a positive impact on road safety while pedestrian bridges increase the probability of crashes for all road users. If the presence of pedestrian bridges along major arterial roads is positively associated with higher levels of crash severity (fatalities and injuries), it is important to further analyze this type of infrastructure including the role of pedestrian fencing, determine the level of use, reevaluate its need, and study its replacement if necessary.

Results for vulnerable-user models suggest that built environment features affect vulnerable users differently. For pedestrians, including more midblock safe crossings might be key to improving their safety. Also, urban infrastructure that incentives high speeds, such as pedestrian bridges, have a significant negative impact all road users. As for cyclists, the results show similar associations but their safety should be further explored using other variables involved in infrastructure design such as the five main principles of

design requirements for cycling infrastructure (Ministerio de Transporte de Colombia, 2016).

The effect of pedestrian bridges and BRT users, who cross the road instead of using the bridge in order to avoid paying, also needs to be studied as a life risk. Infrastructure improvements where pedestrians and BRT users could access the stations without being penalized, in terms of the length and time, could improve road safety for all users, as could access at ground level instead of pedestrian bridges which would could decrease speeds around BRT stations. In the short term, speed management measures for BRT buses should be implemented in areas with higher concentrations of road crash victims involving BRT vehicles.

Regarding the results discussed of the effects of the different BRT phases on road safety outcomes, policy measures to improve the infrastructure for Phase 1 should be implemented. This is especially true for Av. Caracas, Bogotá's main arterial road for public transit, where it is important to conduct maintenance around BRT stations, implement speed management measures, and improve infrastructure conditions. It is also important to consider urban design measures that reduce pedestrian exposure at the intersections along these corridors.

Acknowledgements

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Annex

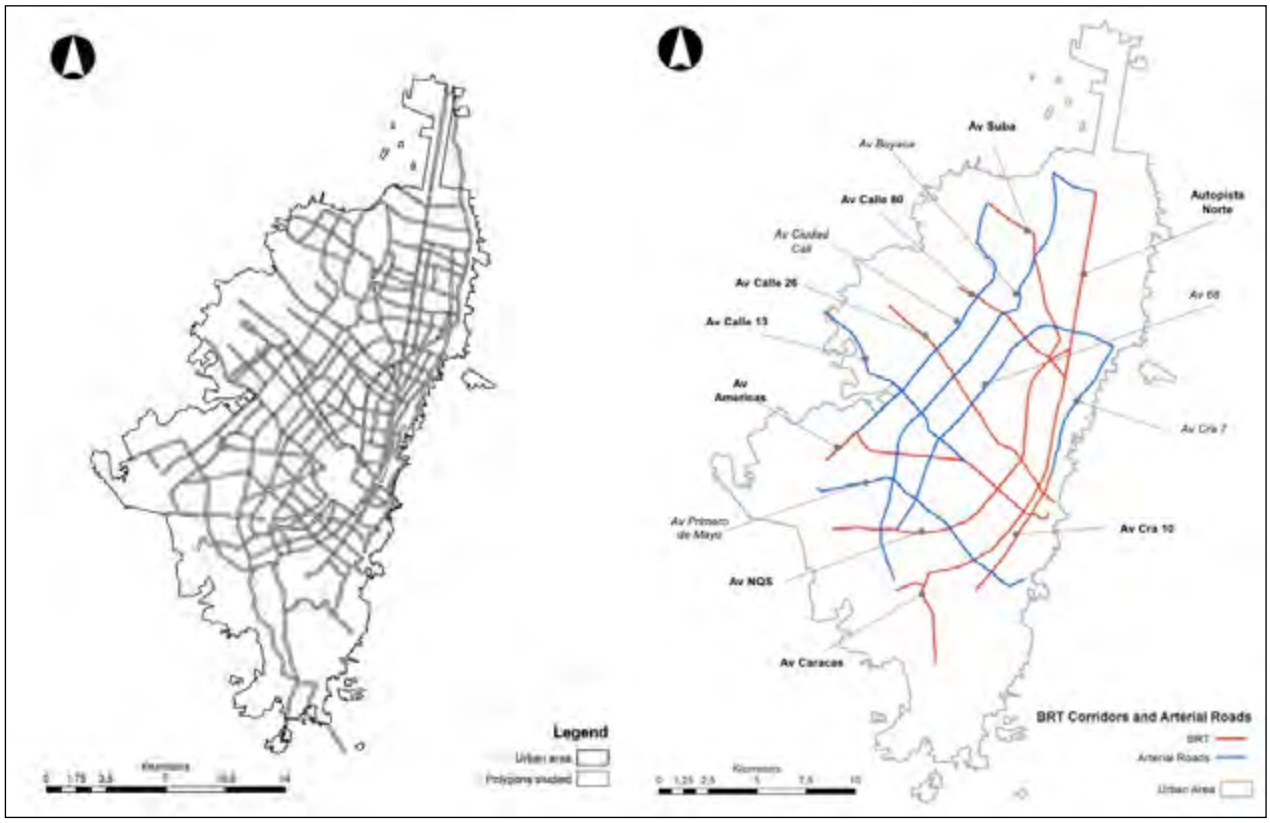

Figure 1. Study areas.

Source: Authors based on Alcaldía Mayor de Bogotá (2017, 2018)

Poligons studied in Bogota

Polygons in detail (arterial roads)

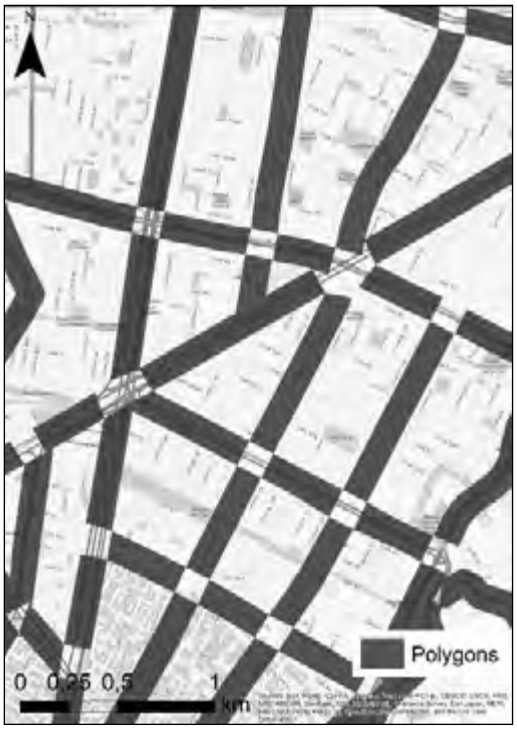

Figure 2. Polygons studied.
Source: Authors based on Alcaldía Mayor de Bogotá (2017, 2018)

Example of pedestrian bridge in front of a hospital in Av. Boyaca and Carrera 18b from an orthophoto

Example of the same pedestrian bridge from Google Street View

Figure 3. Pedestrian bridge in Bogota.
Source: IDECA mapas.bogota.gov.co (2020) and Google Street View (2020)

Investigating the Availability and Usage of Seatbelts in Malawi for Policy Review and Formulation

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Key Findings

- Even though over 90% of the motor vehicles in Malawi were found equipped with seatbelts, the overall seatbelt usage rate was 35.8%.
- Generally, the availability and usage of seatbelts were lower in bigger vehicle classes such as trucks compared with smaller vehicle classes such as cars.
- Passengers recorded a higher usage rate (62.7%) in drivers using seatbelts.

Abstract

Road fatalities remain a major public health concern as over 1.3 million people across the world die in road accidents annually, and another 20-50 million sustain injuries. Malawi, with vehicle ownership about 437,416, has not been an exception to this, with reported fatality rates of 35 crash deaths per 100,000 population, possibly due to limited understanding of factors that contribute to such high road fatality rates. This may have resulted in implementing inappropriate and ineffective mitigation measures. Thus, the overall objective of this study was to investigate the availability, including their functionality and usage of seatbelts in motor vehicles, which could possibly be one of the major factors for increase in road fatalities. To establish the rates of availability, including their functionality and usage of seatbelts in motor vehicles, primary data through survey for a sample of 1,200 vehicles were investigated. The independent variables of data were cross tabulated with the dependent variables to establish these rates. Chi-square test was also performed to establish the significance of associations between the cross tabulated variables. The analysis found that Malawi's drivers and passengers poorly comply with seatbelt laws. The overall seatbelt usage rate was 35.8%. In this regard, where over 90% of motor vehicles in Malawi have functional seatbelts, poor enforcement of existing seatbelt laws and awareness on the dangers of not using seatbelts could account for the low usage.

Keywords

Road fatalities, Seatbelt availability, Seatbelt use, Motor vehicles, Malawi.

Introduction

Road fatalities remain a major public health concern as over 1.3 million people across the world die in road accidents annually, and another 20-50 million sustain injuries. Malawi, with vehicle ownership about 437,416 (WHO, 2015), has not been an exception to this, with reported fatality rates of 35 crash deaths per 100,000 population (WHO, 2015). This fatality rate is quite alarming as it is the second highest in Africa, after Libya (73.4 deaths per 100,000), and the highest in the Southern African Development Community (SADC) region (WHO, 2015). Figure 1 compares road fatality rates among SADC countries.

The trend of road fatalities in Malawi can also be seen to be increasing (Figure 2). Road fatalities have increased from 342 in 2000 to 1241 in 2019, giving a variation or an increment of about 263%. Malawi is experiencing such high number and rates of road fatalities possibly due to limited understanding of factors that contribute to high road fatality rates in the country. This may have resulted in implementing inappropriate and ineffective mitigation measures. On the basis of this observation, it is likely that Malawi will considerably fail to meet fatality reduction targets set in its road safety strategy (WHO, 2015) and, most important, the goals of "Decade of Action for Road Safety 2011 to 2020" to achieve a reduction in its road fatalities by 50% by the end of the year 2020 (Peden, 2010; Raffo et al., 2013). In this regard, to improve road safety, there is need for Malawi to review the existing policies and formulate effective policing measures.

Although a number of factors such as; over speeding, drunken driving and non-use of seatbelts impact road fatalities, literature have indicated that seatbelt non-use has greater influence on road fatalities (Abay et al., 2013; Abay, 2015). For example, based on the National Highway Traffic Safety Administration 2013 data of USA (NHTSA, 2013) reported in the WHO Global Status Report on Road Safety (WHO, 2015), non-use of seatbelts and booster seats

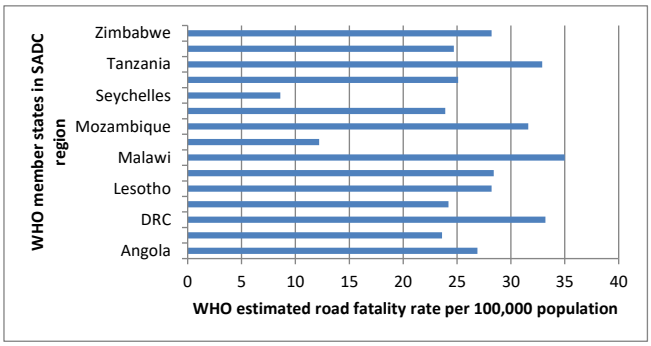

Figure 1. Comparative road fatality rates for SADC countries. Source: WHO (2015)

contributed to as many crash deaths/fatalities as due to over speeding. Also from the policy perspective, seatbelt use can be enforced with less capital intensity compared to other factors as enforcement of seatbelt laws or policing the use of seatbelts generally does not require any equipment. For the reasons explained above, a decision has been arrived to investigate such factors in Malawi as a contribution towards addressing the growing problem of road fatalities. Thus, the overall objective of this study is to investigate the usage of seatbelts in motor vehicles, which could possibly be one of the major factors for increase in road fatalities. However, to assess the rates of seatbelt usage in Malawi, an investigation on the availability of seatbelts in motor vehicles, including their functionality has also been considered. *This study-cum-investigation was undertaken to ascertain the report made by Forjuoh (2003) in his studies of traffic-related injury prevention interventions for low-income countries that half or more of the vehicles in developing countries might lack seatbelts or functional seatbelts. Hazen and Ehiri (2006) in their studies that investigated road traffic injuries as a hidden epidemic in less developed countries also reported that less than half of automobiles in developing countries are out-fitted with functional seatbelts*. As such, it would have been unrealistic to conduct a study or an investigation on the seatbelt usage where the majority of vehicles lack seatbelts or functional seatbelts. In this regard, the study specifically seeks to establish the rates of availability, including their functionality and usage of seatbelts in motor vehicles in Malawi.

Literature review

A number of studies have demonstrated the importance of using seatbelts by both passengers and drivers. Using

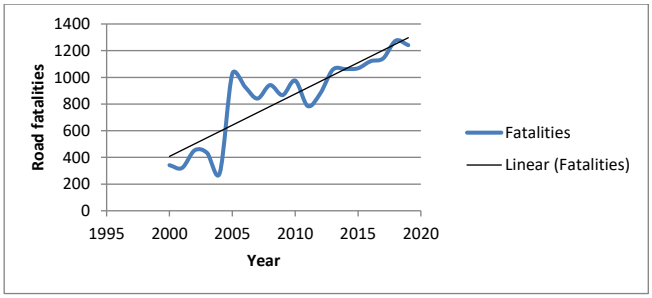

Figure 2. Malawi's road fatalities 2000 – 2019. Source: National Crash Database

seatbelts mitigates fatalities and serious injuries sustained in a road accident (Wang and Jiang, 2003; Shults et al., 2004; Bendak, 2005). Studies have shown that restrained occupants are most likely to reduce the risk of sustaining serious and fatal injuries in a crash by 40-65% (Crandall et al., 2001; National Highway Traffic Safety Administration (NHTSA), 2002; Peden et al., 2004; Elvik and Vaa, 2004). For example, in the USA, increased seatbelt usage to 83% in passenger cars saved about 13,250 lives in 2008 and more than 75,000 between 2004 and 2008 (NHTSA, 2009). Similarly, in Canada, improved seatbelt usage rates contributed to a 17% fatality reduction (Sen and Mizzen, 2007). Other studies have also indicated that vehicle occupants who use seatbelts are less likely to sustain fatal or serious(Wulu, Singh, Famoye, & McGwin, 2002) injuries compared to those who do not use seatbelts (Abay et al., 2013; Abay, 2015). Seatbelts, when properly worn, prevent vehicle occupants from being ejected from the vehicle, colliding with the vehicle interior or with each other thus, reducing the risk of fatal and serious injuries (NHTSA, 2005; 2009; Abbas et al., 2011).

Consequently, seatbelt non-use can be detrimental to road safety. It is estimated that the risk of unrestrained vehicle occupants sustaining severe injuries is double that of those who use seatbelts (Peden et al., 2004; NHTSA, 2010; Abbas et al., 2011). Research has also shown that the majority of road fatalities are a result of the non- use of seatbelts and this is regardless of the fact that the number of those who do not use seatbelts is less than those who use seatbelts (Lerner et al., 2001). For example, the analysis of crash reports in Malawi showed that mortality rate reduced for people who used seatbelts compared to those who did not use (Kuotha et al., 2016). Similarly, in the United States (US), of all crash deaths that occurred in 2009, about 53% involved people who were not using seatbelts at the time of the crash (NHTSA, 2010). Again, about 54% and 61% of all people who were killed and seriously injured, respectively, in road accidents in the New York State in 1998 were those who did not use safety belts (Lerner et al., 2001). In Spain, over 50% of all people who died in road crashes in 1998 were also those who did not use seatbelts at the time of the crash (de Accidentes, 1998).

While seatbelt usage is important in mitigating crash severity, there is also a relationship between the use of the devices and driver attributes, and, ultimately, high severity crashes. The assumption is that unrestrained drivers are more likely to drive aggressively and be involved in high severity crashes compared to belted drivers (Eluru and Bhat, 2007; Christoforou et al., 2010; Abay et al., 2013). To ascertain this claim, Evans (1996) undertook a research that examined the relationship between seatbelt use in drivers and their unsafe or aggressive driving. The study found that unbelted drivers are far more involved in high severity crashes than restrained drivers are. Dee (1998) also reported that high crash-prone drivers are more likely not to use seatbelts relative to cautious drivers. Unbelted drivers are also more likely to drive faster than those that are belted (Shinar, 1993; Janssen, 1994).

On the basis of the literature review presented above in relation to consequences of not using seatbelts in a crash, seatbelt use in Malawi also need to be investigated to relate seatbelt usage rates with the high number and rates of road fatalities.

Materials and Methods

Primary data were analysed to establish the availability, including their functionality and usage of seatbelts in motor vehicles in Malawi. The following discusses mainly the data sources and methods used for collecting and analysing the data.

Sampling and Sample Design

Sampling frame

The sample for investigating the availability, including their functionality and usage of seatbelts in motor vehicles was drawn from national vehicle population. By June 2014, Malawi was reported to have registered about 437,416 vehicles (WHO, 2015). However, the actual vehicle population for study was 412,473, less 24,934 for motorised 2- and 3-wheelers (Table 1) which are exempted from seatbelt laws.

Table 1. Total registered vehicles in Malawi by June, 2014

Vehicle category	Registration numbers
Cars and 4-wheeled light vehicles	332,542
Motorised 2- and 3-wheelers	24,943
Heavy trucks	51,518
Buses	28,413
Total registered vehicles	**437,416**

Source: WHO (2015)

Sample size

There are four approaches that are commonly adopted when determining the sample size, which are: [1] the whole population taken as a sample when population is small (≤ 200), [2] a sample size adopted in a similar study, [3] use of published statistical tables and [4] a formula for calculating sample size (Israel, 1992). Since population size for this study was greater than 200 and there were no similar studies, approaches [3] and [4] appeared suitable for determining the appropriate sample size.

In view of this, the following formula and hence the statistical tables suggested by Israel (1992) has been used for this study.

$$n = {}^{N}/_{1 + Ne^2} \quad (1)$$

where is the sample size, is the study population, and is the level of precision (commonly between 3-10%).

For a study population of 412,473, the appropriated sample size determined from statistical tables published by Israel (1992) was 1,200. This is a suitable sample size for a population of greater than 100,000 at confidence level of 95% and precision of ±3%. Therefore, 1,200 vehicles was the sample size used in this study to investigate the availability, including their functionality and usage of seatbelts in motor vehicles in Malawi, respectively.

Sampling strategy

The survey on the availability, including their functionality and usage of seatbelts in motor vehicles was proposed to be conducted nationwide. It, thus, covered all the four (4) geo-political regions of Malawi, namely: Northern, Central, Eastern, and Southern regions. This was ideal for national representation and generalisation of the results.

Since traffic volumes across the road network are concentrated in major cities, the survey on the usage of seatbelts also focused on cities and major roads. The major cities of Malawi are Lilongwe, Blantyre, Mzuzu and Zomba. Whereas, the sites for collecting data for investigating the availability, including their functionality of seatbelts in motor vehicles were the vehicle test centres and weighbridge stations, located countrywide. In each region, there is atleast a vehicle test centre and weighbridge station, which is ideal for generalisation of the results.

While the regions for study were non-randomly selected through convenience sampling, their regional representative samples were proportionally stratified. The stratified sample was based on the weighted size of the population of the region (Table 2). In addition, the traffic or vehicles for study were selected through purposive sampling i.e., only those with a clear interior view which allowed the observation of the seatbelt use of the vehicle occupants. Similarly, only vehicles reporting for the services of the vehicle test centres or weighbridge stations were inspected for the availability of seatbelts.

Table 2. Sample representation by geographical region

Region	Population size (tally)	Population size (%)	Regional sample size split	Sampling location
Northern	1,965,000	13.1	157	Mzuzu City
Central	6,315,000	42.1	505	Lilongwe City
Southern	4,110,000	27.4	329	Blantyre City
Eastern	2,610,000	17.4	209	Zomba City
Total	**15,000,000**	**100**	**1200**	

Source: NASO (2015)

Data Collection Instruments and its Administration

The instruments proposed for collecting data for investigating the availability, including their functionality and usage of seatbelts in motor vehicles were field datasheets. The field datasheets used for recording data for the availability of seatbelts in motor vehicles (see Table A1 in the Appendix) contained information such as: [1] data sheet number, [2] geographical region, [3] site name, [4] date of inspection, [6] observer's name, [7] vehicle registration/chassis number, [8] vehicle category and [9] vehicle registration status, [10] seatbelts available or not, and [10] seatbelts functional or not. The registration or chassis number helped to identify vehicles that might have been recorded more than once. Whereas, those used for recording data for the usage of seatbelts (see Table A2 in the Appendix) provided information such as: [1] data sheet number, [2] geographical region, [3] site location, [4] day of the week, [5] date and time of observation, [6] observer's name, [7] vehicle category, and [10] occupant using seatbelt or not.

Collection of data for the availability, including their functionality of seatbelts in motor vehicles was delegated to staff who were working in the vehicle test centres and weighbridge stations which were sites for collecting this data. The data for investigating the usage of seatbelts were collected by author as it involved travelling. In the process, Table A1 was administered to staff for their use in recording data, while the author used Table A2. Using staff for the latter task, which involved travelling, would have meant to close down vehicle test centres and weighbridge stations, or scale down their services hence disrupting service delivery.

Data Collection Techniques

'Vehicle' survey is the strategy that was used to collect data for this study. Motor vehicles reporting for the services of the vehicle test centres or weighbridge stations were inspected to establish if they were equipped with seatbelts. The seatbelts were also checked to verify their functionality. A seatbelt is classified functional if it slides when pulled gently and jams when pulled harshly. Further consideration was that the seatbelt should be able to lock in its ratchet catch. These observations were reported in Table A1.

Direct observation was the method used for collecting data for investigating the usage of seatbelts. Under this method, the researcher gets information without asking from the respondents and without their knowledge that they are being investigated (Kothari, 2004). Because observation was almost impossible from passengers who were occupying rear seats due to restricted view, the strategy to include these occupants was abandoned as such seatbelt usage was observed from drivers and front-seat passengers. This has an impact on road fatalities as seatbelt usage for those occupying rear seats was not assessed to quantify their risk of not using seatbelts and that of the front-seat occupants as their risk even if they are belted increases about five times when rear-seat occupants are not restrained (Ichikawa et al., 2002).

Seatbelt use by drivers and front-seat passengers was observed by the curb-side and car parks. It was undertaken during day hours only, i.e., from 6a.m. to 6p.m. The observer had to position himself in such a way as to have a clear interior view of the vehicles being observed and made sure that motorists were not aware that their behaviour on seatbelt use was being observed. This was possible by not being in direct contact with motorists through zealous observation and stopping traffic (Kothari, 2004). The observed information on seatbelt use was then recorded in the field datasheets (Table A2).

Data Analysis

The data collected in Tables A1and A2 were captured into computer readable language for easy analysis and were further classified into two major categories: [1] independent variables and [2] dependable variables. Whereas data for variables 'vehicle category' and 'registration status' (Table A1) or 'driver', 'front-seat passengers', and 'vehicle category' (Table A2) were classified under independent variables, 'availability' and 'functionality' (Table A1) or 'seatbelt use' (Table A2) were the dependent variables. The independent variables in respective tables (Table A1 and Table A2) and explained above were cross tabulated with the dependent variables to estimate the rates of availability and usage of seatbelts in motor vehicles. Chi-square test was also performed to establish the significance of associations between the cross tabulated variables.

Whereas cross-tabulation constructed frequency distribution tables that showed variations in the distribution of the dependent variables in the independent variables, the chi-square tested the hypothesis:

"Is the observed relationship between the independent and dependent variables statistically significant?"

At a confidence level of 95%, the test statistics of $p \leq 0.05$ rejected the null assumption (H_0) and accepted the alternative hypothesis (H_1).

Where:

H_0 = There is no significant relationship between the cross tabulated variables.

H_1 = There is significant relationship between the cross tabulated variables

In order to use chi-square tests for determining the significance of associations between the cross tabulated variables, there is need to compute the value of Chi-square (X^2). This is the first step in testing the significance of associations using Chi-square tests.

The value of Chi-square (X^2) can be calculated from this formula:

$$X^2 = \sum \frac{(O_i - E_i)^2}{E_i}, \quad i = 1, 2 \qquad (2)$$

where O_i are the observed frequencies, E_i are the expected frequencies, and i is the series count.

The expected frequency E_i may be defined as follows:

$$E_i = n^{-1} \sum O_i \quad (3)$$

where E_i is the expected frequency and the values of E_i remain constant in all calculations of expected frequencies for a given n series, O_i is the observed frequency, n is the total number of observations and $n^{-1} = 1/n$ is the probability function of the expected frequency.

The second step is to determine the critical value of Chi-square (X^2) from its statistical tables. Using the degree of freedom (DF = n-1) at a desired confidence level or level of significance, the procedure determines the critical value of Chi-square (X^2) from the tables. By comparing the calculated value of X^2 (Eq. 1) with that obtained from the tables, which is the critical value, the study will determine whether the variation in the values supports the null hypothesis or not. For example, if the calculated value (X_C^2) is less than that obtained from the tables, which is the critical value (X_T^2), the results then support the hypothesis (Kothari, 2004).

In this case, where

$X_C^2 < X_T^2$ = supports the assumption

$X_C^2 > X_T^2$ = rejects the assumption

For this study, SPSS software package, Version 19.0 *(IBM Corp., 2010)* was used to construct frequency distribution tables and perform Chi-square tests.

Results

To assess the rates of availability, including their functionality and usage of seatbelts in motor vehicles in Malawi, data collected in Tables A1 and A2 have been considered, respectively.

Availability of Seatbelts in Motor Vehicles

The results presented in Table 3 show that, while cars, SUVs, minibuses, and pick-ups all recorded a 100% seatbelt availability rate, light (66.2%) and heavy (83.8%) trucks were reported with lower rates. Similarly, functionality rates were higher in cars (98.8%), SUVs (100%), minibuses (90.3%), and pick-ups (96.7%) compared to light (63.4%) and heavy (80.3%) trucks. These statistics translate to an overall rate of 96.3% for the seatbelt availability and 93.4% for their functionality. The results further show a p-value (p = 0.000) of less than 0.05 for both associations i.e., between vehicle category and seatbelt availability and functionality, which suggests both relationships were statistically significant.

However, based on the results given in Table 4, there was no relationship between vehicle registration status and availability of seatbelts (p = 0.587) and their functionality (p = 0.264) as p-values in both associations were greater than 0.05. Thus, there was insignificant statistical difference in the availability of seatbelts and their functionality among the three registration categories. This is evidenced by finding all newly registered vehicles (both used and brand-new imports) equipped with seatbelts and all the seatbelts were functional. The rates on availability of seatbelts (96.1%) and their functionality (93.0%) were also very high in the vehicles that were past recorded in the registration system. The overall statistics on availability of seatbelts was 96.3% and 93.4% for their functionality.

Table 3. Seatbelt availability and functionality by vehicle category

Vehicle category	Availability rate (%)	Functionality rate (%)
Cars	100	98.8
SUVs	100	100
Minibuses	100	90.3
Pick-ups	100	96.7
Light Trucks < 4T	66.2	63.4
Heavy Trucks > 4T	83.8	80.3
All Vehicle Types	**96.3**	**93.4**
Significance (p)	0.000	0.000

Table 4. Availability and functionality of seatbelts by vehicle registration status

Registration status	Availability rate (%)	Functionality rate (%)
Past registered in the system	96.1	93.0
Newly registered (imported-used)	100.0	100.0
Newly registered (imported brand-new)	100.0	100.0
Overall	**96.3**	**93.4**
Significance (p)	0.587	0.264

Seatbelt Usage

The results presented in Table 5 show that seatbelt usage was relatively low in all vehicle categories, with the lowest rates observed in light commercial trucks (24.2%), minibuses (17.0%) and heavy commercial trucks (11.5%). A study (Corolado State University, 2013) also reported similar variations in seatbelt usage between smaller and bigger vehicles. When all vehicle categories were combined, the overall usage rate was 35.8%. However, the usage rates were better in drivers (40.4%) compared to passengers (27.7%). Similar to findings in other African countries (Nantulya and Muli-Musiime, 2001; Afukaar et al., 2010; Ismaila and Akanbi, 2010), Malawian drivers and passengers are not compliant with seatbelt laws. The test statistics show a p-value (p = 0.000) of less than 0.05 for both associations i.e., between vehicle category and seatbelt usage in drivers and passengers, which suggests both relationships were statistically significant.

Table 5. Seatbelt usage by vehicle category

Vehicle category	Usage in drivers (%)	Usage in passengers (%)	Overall usage rate (%)
Cars	50.5	40.6	47.5
SUVs	48.3	48.6	48.4
Pickups	48.0	31.8	42.3
Minibuses	20.1	13.2	17.0
Light Trucks < 4T	28.8	18.5	24.2
Heavy Trucks > 4T	11.7	11.3	11.5
All Vehicle Types	**40.4**	**27.7**	**35.8**
Significance (p)	0.000	0.000	

Table 6. Seatbelt usage in passengers by driver usage status

Driver	Passengers using (%)
Driver using	62.7
Driver not using	7.9
All driver usage	**27.7**
Significance (p)	0.000

The results in Table 6 show that passengers recorded a higher usage rate (62.7%) in drivers using seatbelts. In contrast, unbelted drivers were also found with a relatively low usage rate in their passengers (7.9%). Other studies have shown that restrained drivers are more likely to result in higher seatbelt usage in their passengers compared to unrestrained drivers (Letho and James, 1997; Eby et al., 2001). The relationship between seatbelt usage in drivers and their passengers also showed a significant difference between the two variables ($p = 0.000$).

Discussion

Malawi does not manufacture vehicles, but imports them either used or brand-new from industrialised nations such as Japan, America, Singapore, United Kingdom and German. Studies have also shown that most developing countries do not manufacture vehicles, but largely import them from industrialised nations (Forjuoh, 2003; Hazen and Ehiri, 2006). Almost all of these imported vehicles come already fitted with seatbelts Therefore, it should not be surprising for this study to find that the majority (over 90%) of motor vehicles in Malawi having seatbelts. In this regard, these findings can be seen to contradict with the reports by Forjuoh (2003) and Hazen and Ehiri (2006) that half or more of the vehicles in developing countries might lack seatbelts, hence a contribution on the knowledge of road safety.

Having this study found Malawian drivers and passengers with seatbelt usage rates of 40.4% and 27.7%, respectively and thus, not compliant with seatbelt laws, it should not be surprising for studies to find Malawi with high road fatality rates (WHO, 2015; Kuotha et al., 2016) as large proportion of road fatalities is explained by non-use of seatbelts (Abay et al., 2013; Abay, 2015). Apart from consequences of not using seatbelts in a crash, low compliance of drivers with seatbelt laws (40.4%) might have also significantly contributed to the risk of road fatalities in Malawi. This assumption is supported by much of the literature. As stated earlier, research has shown that unrestrained drivers are more likely to drive aggressively and be involved in high severity crashes compared to belted drivers (Eluru and Bhat, 2007; Christoforou et al., 2010; Abay et al., 2013). Dee (1998) has also highlighted that high crash-prone drivers are more likely not to use seatbelts relative to cautious drivers. Unbelted drivers are also more likely to drive faster than those that are belted (Shinar, 1993; Janssen, 1994). In this regard, policing the use of seatbelts and rigorous awareness of dangers or consequences of not using seatbelts among drivers and other occupants could see increased seatbelt usage, less aggressive driving and more lives saved.

Even though the overall seatbelt usage rate was found to be low (35.8%), similarities in the distribution of the availability and usage of seatbelts in vehicle categories can still contribute to road safety. All vehicle categories demonstrated low seatbelt usage, with the lowest rates observed in light commercial trucks (24.2%), minibuses (17.0%) and heavy commercial trucks (11.5%). Similarly, cars, SUVs, minibuses, and pick-ups all recorded a 100% seatbelt availability rate, whereas light (66.2%), heavy (83.8%) trucks were reported with lower rates. On the basis of these findings, it can be assumed that there is a relationship between the availability of seatbelts in motor vehicles and the usage rates, hence a contribution on the knowledge of road safety. This assumption is supported by literature. A study by Corolado State University (2013) also found trucks with lower seatbelt availability rates compared with smaller vehicle classes such as cars, SUVs and others. Similarly, seatbelt usage rates were lower in trucks compared with smaller vehicle classes explained above. Apart from the observed differences in seatbelt usage among vehicle categories, safety consciousness of occupants also varies with the type of the vehicle owned, driving or driven in (Eluru and Bhat, 2007), suggesting that occupants in smaller vehicle classes are more likely to use seatbelts compared to counterparts in bigger vehicle classes such as trucks. The other reason for the study to find higher seatbelt usage in smaller vehicle classes compared with bigger vehicle classes it could be because a large proportion of these imported smaller vehicle classes are seen to have also been equipped with audible or electronic devices that remind an occupant to use seatbelt. Therefore, it can be assumed that lower availability of seatbelts and devices to remind an occupant to use seatbelt and lesser safety consciousness in heavy commercial trucks could be factors for low seatbelt usage in these vehicle classes.

Conclusions

This study has estimated the rates of seatbelt usage in Malawi. The overall seatbelt usage rate was 35.8%. Generally, compliance with seatbelt laws among Malawi's drivers and passengers is low. In this regard, where the majority (over 90%) of motor vehicles in Malawi have functional seatbelts, poor enforcement of existing seatbelt laws and awareness on dangers or consequences of not using seatbelts could account for the low usage.

Having found seatbelt non-use as one of the core risk factors that contribute to road fatalities, it is recommended that in order to mitigate high road fatalities, the government of Malawi should enact legislation and develop appropriate enforcement and awareness mechanism to deal effectively with the risk of seatbelt non-use which contributes to road fatalities. Among the specific legislation, it would be necessary that all vehicle occupants (drivers and passengers) be compelled to use seatbelts. For this to be effective there should be stringent penalties for non-compliance with the set legislation.

This research has a number of limitations. The observed rates on availability and usage of seatbelts in motor vehicles have been established from a single study. Thus, the observed rates may not represent the actual status in Malawi. Another challenge is that observation of seatbelt usage by rear-seat occupants in cars was almost impossible due to restricted interior view. As a result, the original plan to observe seatbelt usage including in the rear-seat occupants was abandoned. Tinted vehicles and raised heavy trucks were also a challenge to access their interior view. Consequently, the observed usage rates may not represent the actual status in some motor vehicle classes. Lastly, under seatbelts, since the study used direct observation as a method of gathering data, it allowed and examined very few variables compared to the self-reporting. As such, important factors that influence seatbelt usage such as age, race, educational level, years of driving, professional driver or not, residence city size, trip distance and attitude towards seatbelt use were not investigated. This means mitigation measures will still be applied across the board, with possibility of mainly treating factors of minor risks.

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Appendix:

Instruments for Recording Data for the Availability and Functionality of Seatbelts in Motor Vehicles and the Seatbelt Usage in Malawi

Table A1. Field datasheet for the availability of seatbelts in motor vehicles, including their functionality

Sheet no			Region:		Date:		Inspector's name:		Site:			
Reg. No.	Cars		S/ Wagons		M/buses		P/ups		Light trucks		Heavy trucks	
	Available (Yes/No)	Functional (Yes/No)	Available (Yes/No)	Functional (Yes/No)	Available (Yes/No)	Functional (Yes/No)	Available (Yes/No)	Functional (Yes/No)	Available (Yes/No)	Functional (Yes/No)	Available (Yes/No)	Functional (Yes/No)

Table A2. Field datasheet for the seatbelt usage

Region:				Date:		Sheet No.			
Site location:				Site No.					
Time start:				Time finish:					
Observer:									
Day of week:		Sun	Mon	Tues	Wed	Thurs	Fri	Sat	
Tally #	Driver		Using seatbelt		Passengers		Using seatbelt		Veh class
	Male	Female	Yes	No	Male	Female	Yes	No	
1									
2									
3									
4									
5									

Key on vehicle classes: 1 = cars; 2 = SUVs; 3 = pickups; 4 = minibuses; 5 = light goods vehicles; 6 = heavy goods vehicles

A Qualitative Study of the Context of Speed Management in Cambodia

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Key Findings

- The context of speed management in Cambodia presents a number of challenges;
- A functional road hierarchy and a less complex speed limit system are needed;
- Effective enforcement requires resourcing and addressing of issues affecting deterrence;
- Knowledge of speed limits is low, and public education has an important role in supporting enforcement and motivating compliance;
- Funding, coordination, data support, monitoring and evaluation need to be addressed.

Abstract

Cambodia has one of the highest road crash rates amongst low-and middle-income countries (LMICs), with speeding a major contributor. Best practice speed management has been promoted internationally, and transfer of knowledge and best practices from high income countries (HICs) to LMICs has been recommended. However there is a need to take account of the physical, social and political environment of the LMIC concerned. The aims of this study were to analyse the context of speed management in Cambodia using the Road Safety Space Model (RSSM), and to recommend how best practice speed management could be implemented. Secondary sources were reviewed, and semi-structured interviews were conducted with 13 key informants with professional experience in speed management and enforcement in Cambodia. The interviews were recorded, transcribed, translated and thematic analysis was undertaken. The findings were interpreted using RSSM, within the categories of economic, institutional and social/cultural factors. Although there are Cambodian government initiatives to address speeding issues, many challenges were revealed. Recommendations are made, aligned with best practice recommendations for speed management. They include establishment of a functional road hierarchy and a review of provisions for different road users; a move away from the current complex vehicle-based speed limit scheme; improved databases to support enforcement, monitoring and evaluation; a review of current legislation and practices around fines and implementation of the licence points system; improvement of the spatial and temporal coverage of enforcement; public education to support enforcement; workplace safety measures to address speeding; and better coordination and funding across government agencies.

Keywords

Cambodia, speed management, speed enforcement, best practice, knowledge transfer, deterrence theory

Introduction

Cambodia, in Southeast Asia is classified among low-and middle-income countries (LMICs). In 2016, Cambodia had 1,852 road crash fatalities in a population of about 16 million (Road Crash and Victims Information System [RCVIS], 2017). This corresponds to a rate of 11.9 fatal crashes per 100,000 people (RCVIS, 2017), more than twice the Australian rate of 4.5 per 100,000 in 2018 (Bureau of Infrastructure, Transport and Regional Economics [BITRE] 2019). An earlier report on Cambodia (when the situation was better) estimated that road crashes cost the Cambodian economy over USD 310 million (2.4% of GDP) (Handicap International, 2012). This exceeds the amount of development assistance received by Cambodia (Chekijian, Paul, Kohl, Walker, Tomassoni, Cone & Vaca, 2014).

Speeding is identified as a risk factor causing road crashes and increasing their severity worldwide (Global Road Safety Partnership [GRSP], 2008) and is acknowledged as an important issue in Cambodia (RCVIS, 2017). Speed Management refers to "an active approach that requires (or persuades) drivers to adopt speeds that offer mobility without compromising safety (Global Road Safety Partnership [GRSP, 2008]). Its aim is to "reduce the number of road traffic crashes and the serious injuries and death that can result from them" (GRSP, 2008). This entails the implementation of multiple measures (enforcement, engineering and education) to produce successful outcomes. GRSP (2008:87) lists the tools required for effective speed management, summarised as follows:

- A road hierarchy based on function, in rural and urban areas
- Appropriate speed limits (based on the Safe System approach) that are clearly signed
- Effective laws and regulations supported by effective enforcement and adequate penalties
- Public education about the risks of speeding, and to support enforcement activity
- Installation of low/medium cost engineering treatments to reduce risk
- New vehicle technologies
- Workplace health and safety legislation and management to reduce work-related driving risk, especially for freight vehicles.

Even in high-income countries (HICs), speed management has only partially succeeded in addressing the aims of reducing numbers and severity of crashes. In Australia, for example, the States and Territories have developed comprehensive speed management strategies and are committed through the National Road Safety Strategy (NRSS) 2011-2020 to a Safe System approach that has four pillars: Safe Road Users, Safe Vehicles, Safe Roads and Roadsides, and Safe Speeds. Overall, there has been a decline in fatalities in Australia at the same time as the population has increased (BITRE, 2019). However the decline has not met the NRSS target, and an inquiry into the NRSS concluded that there is still considerable work to do before full implementation of a Safe System in Australia is achieved (Woolley, Crozier, McIntosh & McInerney, 2018). The same inquiry identified a number of shortcomings in speed management in Australia: rural speeds are too high to be compatible with a Safe System approach; urban speeds are mostly too high for safety of vulnerable road users; and there is insufficient data to monitor travel speeds and levels of speed enforcement in Australia. The report recommended that Australia "Accelerate the adoption of speed management initiatives that support harm elimination" (Woolley et al., 2018:8).

Even though HICs like Australia do not necessarily implement best practice fully, the World Health Organization (WHO, 2004) recommended that LMICs adopt the proven and promising road safety approaches from developed nations' best practices that are suitable and promising for local conditions. Similar comments have been made by Bliss and Breen (2012), and Wegman (2017). However it has also been noted that simply transplanting an intervention or program from one country to another may not give the desired results, because of the specific economic, institutional and social/cultural factors that influence the target issue (King, 2005). HICs have many differences from LMICs apart from the definitional economic distinction, such as income distribution, institutional development, health system capability, infrastructure, social structure, and culture (King, 2005). These potential factors influence road safety management, road infrastructure, vehicle standards, road user behaviour, law and regulation, and law enforcement, and would therefore influence the adoption of speed management in Cambodia. The first aim of this study is therefore to understand barriers and needs of speed management implementation in Cambodia by analysing the context of speeding and speed management in Cambodia. The second aim is to use the analysis of the context to suggest strategies for introducing more effective speed management in Cambodia.

Methods

Following the methodology used by King (2005), the methods employed in this study were qualitative, and comprised an initial review of secondary sources, including secondary data collections, policy documents and existing literature, followed by key informant interviews. Further details are provided below.

Review of Secondary Data, Policy Documents and Existing Literature

Time and resource constraints limited these sources of data to readily available secondary data, and official documents setting out the legislative framework and policies. Many of these documents are in Khmer, some are not available online, and websites may not be up to date. The second author is a Cambodian who previously worked in road safety in Cambodia for a number of years, for a non-government organisation (NGO), and was able to draw on relevant documents accumulated during that time, and contacts who could supply other official (non-confidential) sources. The documents included statistical reports, legislation, policy documents and research reports that appeared in the grey literature. There is very little research on road safety in Cambodia published in the scholarly literature.

The analytical approach followed Platt's (1981a,b) recommendation for document research, which essentially involves taking an inductive, critical approach to the information that is extracted from the documents. Tight (2019) refers to Platt's approach as quasi-legalistic, in the sense that what the documents say is not taken for granted as fact, but is considered as information on a particular topic which is open to reflection on its reliability and credibility. In this study, the limited amount of information available did not allow for much cross-checking of sources, however it was possible in some cases to relate secondary source information to the interview data.

Interviews with Key Informants and Context Analysis

Recruitment and sample characteristics

Snowballing and purposive sampling were utilized to recruit key informants in Cambodia, and in addition an Australian road safety consultant with extensive Cambodian experience was interviewed. The criteria for inclusion were involvement in road safety policy implementation, especially speed management and speed enforcement in Cambodia, and to be at least 18 years old. Ethical approval was granted by the Queensland University of Technology, and the participant

information sheet and informed consent form were translated into Khmer to ensure that participants fully understood the purpose of the research and their role. All participants were sent these documents prior to the interview, via e-mail, WhatsApp, or Facebook Messenger.

Eighteen eligible people were approached and five declined. The 13 participants were aged between 29 and 74 years old and their education ranged from undergraduate to PhD degree. Four were female. Five participants came from government agencies such as the National Road Safety Council, the Ministry for Public Works and Transport and the Ministry of Interior, and seven were Cambodian road safety consultants or experts. All participants have a professional knowledge of speeding and speed management in Cambodia. There is a limited number of eligible people in Cambodia, and those interviewed constitute a large proportion of them. As this made the government employees potentially reidentifiable from their comments if information was given on their current employment, a condition of ethical approval was that the labels for participant quotes only give a participant number (P1 to P13).

Data collection

Semi-structured interview questions adapted from King (2005) were used in interviews with the key informants. Each interview began with general questions, then progressed to more specific questions which depended on individual's reflections and perspectives on the challenges of speed management and enforcement in Cambodia as well as their perceptions of driver speeding behaviour. The interviews were conducted between October and November 2019 through online means such as phone calls, Skype, and Facebook Messenger, and lasted between 47 and 87 minutes. After each interview, new ideas or questions were identified for use in subsequent interviews, i.e. an iterative process was adopted. Saturation of information was achieved before the final interview.

Analytical approach – thematic analysis and application of the Road Safety Space Model (RSSM)

The thematic analysis approach is described in the next subsection ("Data processing and analysis"), however its form was influenced by the intention to structure the themes to describe the Cambodian context of speed management. This utilised the Road Safety Space Model (RSSM) developed by King (2005). It is an ecological approach to assist the process of transferring road safety measures from HICs to LMICs, defining the "road safety space" as similar to an ecological space:

> "Each road safety issue in a given country exists in a space defined by the economic, institutional, social and cultural factors which influence it. The factors include both broad and specific influences. The road safety space varies from one road safety issue to another, and from country to country, although some factors may be shared across road safety issues or across countries." (King, 2005:97)

The space is represented in Figure 1, which also forms a template for visually mapping the factors that influence the road safety issue in question.

The RSSM has been used to analyse the road safety context in several settings such as drink driving in Ghana (King, Damsere Derry, & Jia, 2016), road safety education in Thailand (King, 2005), motorcycle helmet wearing in Vietnam (King, 2005), and vulnerable road users in Brazil and India (Persia, Corazza, Mascio, Musso, & Tripodi, 2011). More recently it has been proposed as an essential

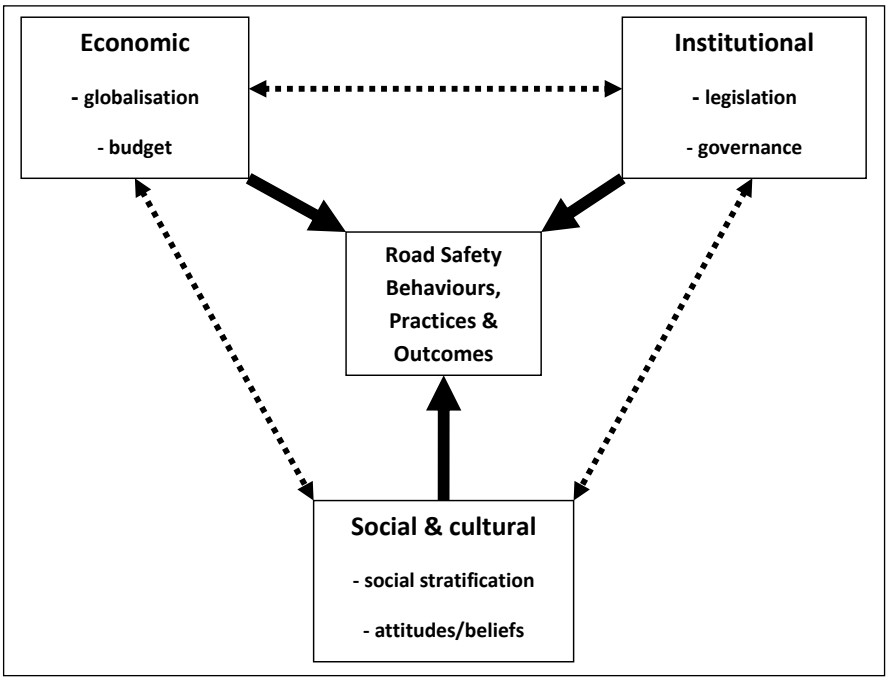

Figure 1: Model of the 'road safety space' of contextual factors (Source: King, 2005:100). Note that only limited examples of contextual factors are given

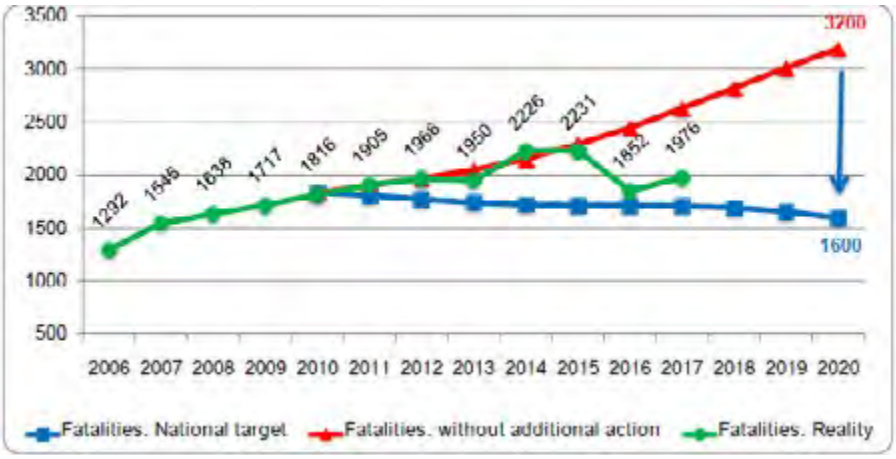

Figure 2: Estimated number of fatalities 2011-2020 (RCVIS, 2017)

step in applying the traffic safety culture concept to LMICs (King, Watson & Fleiter, 2019). The model is intended to facilitate an understanding of the complex, multi-level influences on a road safety problem or issue in a country, to assist in identifying the barriers to, and facilitators of, possible interventions. Because these potential interventions might have been developed and evaluated in quite different contexts, in which important facilitators may have been taken for granted which are absent in the target country's context, such an analysis can inform the choice, design and implementation of interventions.

Data processing and analysis

All interviews were audio recorded and then transcribed and translated verbatim from Khmer to English, except one interview in English. The data was qualitatively analysed using a form of thematic analysis (Braun & Clarke, 2006). Rather than "open coding", the analysis aimed to identify themes based within the broad a *priori* RSSM categories of economic, institutional, social and cultural factors, an approach that represents a simple form of the Framework Method of thematic analysis (Gale, Heath, Cameron, Rashid & Redwood, 2013). To identify classification variables, each interview transcript was read several times, and key words and phrases were highlighted. To ensure the categorized themes addressed the research aims, some data that were included in the initial stage of analysis were reassessed and then excluded. The remaining variables were classified under each theme. This was initially carried out by SP, and verified by MK. Examples of quotes have been provided in the Results section to support the classification.

Results and Discussion

Speeding and Speed Management in Cambodia – Secondary Data and Official Documents

Crashes and speed-related crashes

Over the past 10 years the Cambodian Government has been guided by its National Road Safety Action Plan-NRSAP 2011-2020, which aimed to reduce road crash fatalities by 50% by 2020. Figure 2, which gives data to 2017 from RCVIS, indicates both an initial upward trend followed by a downward correction (RCVIS, 2017); however, this is the last official RCVIS report and gives data to 2016 only. It is uncertain how the 2017 figure in Figure 2 was derived – possible an estimate based on part of a year - and Sann (2017) has noted that the completeness of the RCVIS data has declined over time. Although the green line is stated to be "Fatalities: Reality", it would be more accurate to refer to it as "Reported Fatalities" to acknowledge the likely inaccuracy of the data. The Global Status Report on Road Safety (WHO, 2018) estimates that the actual fatality figure for 2016 was around 2,803, which is about 1,000 higher than the RCVIS figure and higher than the corresponding point on the red line in the figure. This suggests that the road fatality situation has not improved in the past decade, may have worsened, and is not being tracked accurately.

According to RCVIS (2017), human error contributes to 95% of road fatalities in Cambodia. This is based on police opinion and reports of those involved in the crash rather than a detailed investigation, hence is likely to be inaccurate. Speeding is stated to be a leading cause of these road fatalities (38%), and head-on collisions represent the most common collision type for deaths related to speeding (29%). With respect to the type of road user, motorcycle riders and pedestrians comprised 65% and 15% of total deaths from speed-related crashes respectively. The high proportion of motorcyclist deaths is consistent with registration figures that show that powered two-and three-wheelers comprise 85% of vehicles registered (Kong, 2018). Over two-thirds of at fault-drivers causing speed-related crashes were young drivers aged between 15 and 34 years old (71%), whereas around a third of the population (and around half of the population aged 15 and above) are in this age category. In addition, 16% of the at fault-drivers in speed-related crashes were suspected of driving under the influence of alcohol.

The RCVIS report notes that multiple factors contributed to speed-related crashes: road infrastructure deficits, lack of awareness and education, limited knowledge amongst road users, and issues with road designs and traffic signs. It states that there were developments and significant improvements

Table 1: Monetary penalties for speeding by vehicle type, Cambodia (RGC, 2015c)

Infringement	Penalty amount Cambodia (Riels)		Points	Penalty amount in USD			
	Motorcycle and tricycles	Light vehicles	Heavy vehicles	All	Motorcycle and tricycles	Light vehicles	Heavy vehicles
1-19 Km/h	15, 000	25, 000	50, 000	1	3.67	6.12	12.24
20-29 Km/h	20, 000	40, 000	75, 000	2	4.90	9.80	18.38
30-39 Km/h	25, 000	50, 000	100, 000	3	6.12	12.24	24.48
40-49 Km/h	30, 000	60, 000	125, 000	4	7.34	14.69	30.60
50 Km/h +				6			

in the preceding five years (2012-2016) (RCVIS, 2017) although no evidence is provided.

Road traffic laws

Royal decree NS/RKM/0115/001, the New Cambodian Road Traffic Law, was approved on 6 January 2015. Article 17 makes drivers responsible for driving at a safe speed for the conditions (The Royal Government of Cambodia [RGC], 2015a), and article 5 of Sub-decree No.86 (approved on 8 July 2015) establishes maximum speed limits for different types of vehicles (RGC, 2015b):

- In cities/towns:
  - 30 Km/h for motorcycles, tricycles and agricultural vehicles
  - 40 Km/h for other vehicles
- Elsewhere:
  - 40 Km/h for tricycles, motorcycles with trailers, and agricultural vehicles
  - 60Km/h for motorcycles with capacity <=125cc, vehicles with trailers, and all types of trucks (except heavy trucks)
  - 70 Km/h for motorcycles with capacity > 125cc, and goods vehicles (heavy trucks)
  - 80 Km/h for light vehicles and passenger vehicles
  - 90 Km/h for light vehicles and passenger vehicles on roads with divided lanes

This mixture of speeds is complex and potentially frustrating where there is high traffic and a mix of vehicle types. Table 1 indicates the monetary penalties for speeding, which differ by vehicle type as well as speed above the relevant limit. Licences are issued with 12 points, with the intention that points will be deducted for various offences, though no more than 8 points can be deducted for the one incident. After three years, if there are still points remaining, the driver reverts to the full 12 points again.

Note that Table 1 also gives the value of the fines in USD. To enable a comparison with Australian fines, so that the relative magnitude of the fines can be compared, a Purchasing Power Parity (PPP) conversion was undertaken to correct for differences in Gross Domestic Product (GDP) (OECD, 2012). Using PPP values, GDP per capita for Australia is 46,789.93 USD and for Cambodia is 3,744.219 USD (Index mundi, n.d.). Table 2 shows first a simple conversion of the Queensland fines from AUD to USD, then a conversion using the PPP values to the PPP equivalent of Cambodia (multiplying the Queensland figure by 3,744.219/46,789.93). The minimum speeding fine in Queensland is equivalent to 9.06 USD in Cambodia, almost three times higher than Cambodian minimum (3.67 USD), although for heavy vehicles it is less. The maximum speeding fine in Queensland is equivalent to 63.76 USD in Cambodia, more than twice the maximum Cambodian fine (30.60 USD)

Table 2: Comparison of speeding fines in Queensland vs Cambodia in terms of Purchasing Power Parity (PPP)

Infringement	Penalty amount Queensland in USD	PPP conversion to USD Cambodian equivalent
Less than 13 Km/h over the speed limit.	113.28	9.06
13-20 Km/h	170.24	13.62
21-30 Km/h	284.16	22.74
31-40 Km/h	398.08	31.86
More than 40 Km/h over the speed limit.	796.80	63.76

Speed enforcement and deterrence

The Commissariat of National Police issued an official order on 1 September 2010, following on from an enforcement action plan issued on 26 March 2012, to enforce land traffic law in Phnom Penh and all provinces (Tun, 2015). Subsequently speed monitoring was implemented along national roads, especially blackspots, building on the five year (2009-2013) implementation of speed enforcement checkpoints through collaboration between national and local police, on national road sections with speed limit signs (Tun, 2015). An interesting aspect of the allocation of fine

revenue specified in legislation is that 70% of the revenue from land traffic penalties is returned directly to the traffic police who conducted the enforcement. There is a risk that this could bias enforcement activity towards the optimum combination of fines issued per unit time and fine size. This was also addressed by key informants and is mentioned again below.

Road design and infrastructure

Limited information relevant to speed management and road factors was found. Although there are supposed to be designated motorcycle lanes and bicycle lanes, there is no clear delineation of lanes on most of Cambodia's roads and so road users with different speed limits interact with each other. In addition, pedestrians are often forced to use the roadway as footpaths are often absent or obstructed by shops, parked vehicles and debris (King, King, Edwards, Hair, Cheang, Pearson & Coelho, 2018). This creates an environment in which road users of varying levels of vulnerability and differing legal requirements with respect to speeding are mixed together, which presents both a safety problem and practical difficulties for police enforcement. Without clear delineation of lanes for different road user types, and compliance with them, it seems unlikely there is much value in having different speed limits for different vehicle types.

Speeding behaviour

Handicap International conducted a knowledge-attitude-practice (KAP) survey on speeding in Cambodia in 2010 (Ear et al., 2011 cited in Tun, 2015). The survey found a very low level of knowledge of speed limits amongst participants in general, and only 19% of respondents knew the speed limit for cars in urban areas. Only 11% understood a traffic sign giving the maximum speed limit while less than 2% recognised a traffic sign giving the minimum speed limit. Over 50% of respondents were aware of speed enforcement and most of them supported law enforcement (Ear et al, 2011 cited in Tun, 2015). The study also reported reasons stated for driving fast, such as being in a hurry (92.6%), saving time (16%), and being afraid of being robbed at night (9.5%).

Another study on speed behaviour conducted by Handicap International (Tun, 2015) found that over half of all types of drivers exceeded speed limits. Vehicles with trailers represented the highest rate of speeding, followed by buses with less than 20 seats. Moreover, 40% of participants reported driving at an excessive speed in the last three months, although 86% stated they felt nervous driving at these speeds.

The level of support for law enforcement in relation to speeding is promising, and the reported anxiety experienced when driving at excessive speed could contribute to motivation to comply, for example in public education messages. Clearly there is a need to address the low level of knowledge of speed limits and the understanding of speed limit signage, and the high level of self-reported speeding. It seems likely that this would require speed enforcement at a high enough intensity, supported by public education that gives road users information on speed limits and signage, and highlights the increased level of enforcement.

Context Analysis Based on Thematic Analysis of Key Informant Interviews

The themes that emerged from the thematic analysis were mapped onto an RSSM template derived from the diagram in Figure 1, using the same approach as King (2005), and King et al. (2016). The mapping (Figure 3) involves spatially

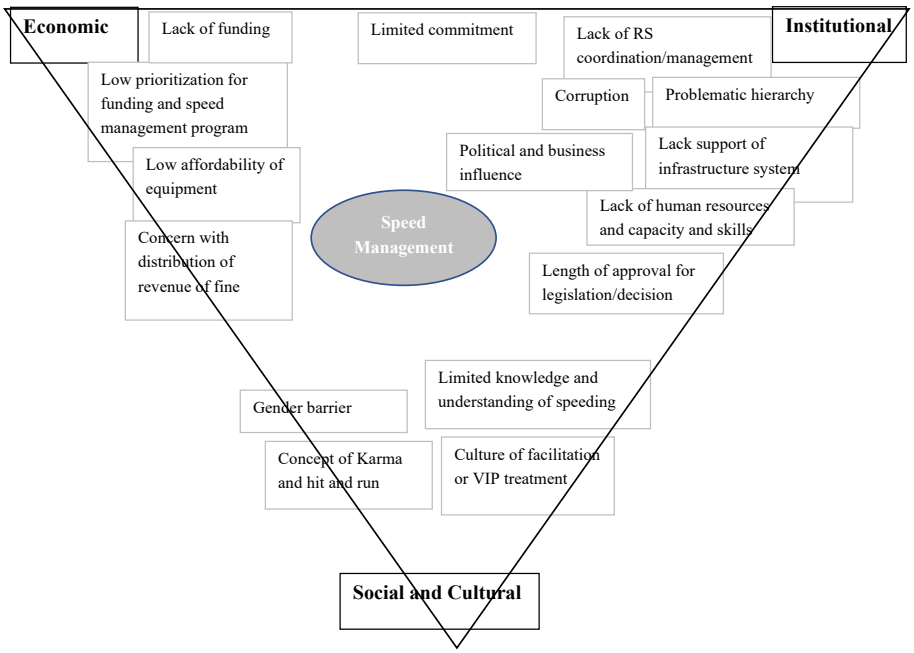

Figure 3: Road safety space for speed management in Cambodia

assigning themes to locations on the template based on two criteria: first, since some themes show an overlap between the three categories (economic, institutional, social and cultural), they are positioned between the corners to indicate this (e.g. "limited commitment" in the diagram involves both limited institutional commitment and limited economic commitment); second, how closely they are positioned to the centre (the road safety issue of interest) represents the degree to which they are macro (operating at national level or across a range of issues, e.g. the time it takes for legislation to take effect) or micro (directly related to speed management, e.g. police speed enforcement practices).

Although there are overlaps between factors in the degree to which they are economic, institutional or social/cultural, they have been clustered in the discussion below according to the dominant category. For space reasons, only a limited number of relevant quotes have been included to illustrate the themes.

Economic factors

Low prioritization of road safety funding and speed management was observed. A majority of participants stated that road safety is not yet prioritized by the Cambodian Government, relevant ministries, donors, the private sector and NGOs. There were assertions that this is due to non-approval of a proposed budget for road safety due to the government having a limited budget and other priorities such as supporting the health sector, education, and road construction. This hampers the building of capacity in human resources, purchase of equipment for enforcement, replacement of old speed-related traffic signs and treatment of blackspots. It is also consistent with previous studies that show low government investment in road safety in LMICs (e.g., Bishal, Hyder, Ghaffar, Morrow, & Kobusingye, 2003). One participant believed that potential donors and the private sector are not interested in road safety. There is a plan to fund road safety by selling special vehicle plates, however, it is likely that this will make only a small contribution.

> P08 *"...The budget that the government has allocated for road safety is limited, road safety is less prioritized if compared to other fields…. Each ministry always requests budget for their activities annually, I think it may be the same for road safety activities.., but it may be inadequate for implementation to address this issue"*

The consequence is low affordability of speed management equipment and a lack of budget for capacity building and speed management implementation. According to participants, there is not enough equipment for enforcement, such as speed measuring cameras and the like, and other equipment which would enable more enforcement at the district and commune level (discussed further below).

Due to the limited budget, the intervention strategies related to speeding tend to focus more on awareness and education, but not awareness about law enforcement. They focus on general risk factors including speeding, but there are no dedicated speeding program awareness or education programs. A reason advanced for lack of funds was due to previous funding being donor driven, however this funding had ceased and was not replaced with government funding.

> P04 *"Speeding is difficult to implement … 1. we find it difficult to cooperate with the government and 2. we don't have equipment to implement speed management… 3. we don't have funding from main donors…"*

Two participants were concerned about the distribution of revenue from fines in Cambodia. The distribution is set by Cambodian Land Traffic Law, and includes the provision that 70% of the fine revenue is returned to the police officers who were conducting the enforcement operation that led to the fine. This issue (which is a combination of economic and institutional) was noted in the discussion of the secondary source analysis as potentially distorting enforcement priorities.

At the level of personal economic considerations, the general deterrence requirement of a high perceived severity of punishment needs to be followed up, as there were differing views about whether the size of the penalty was enough. It was noted that the fine did not matter for high income people, especially as there is the points deduction system has not been implemented (addressed in the next section).

> P03 *"…The penalty related to point deduction of driving license, we haven't implemented yet……. because sometimes our population have not clearly understood about traffic law"*

Institutional factors

Low commitment from the government, the private sector and road safety networks in Cambodia was mentioned at both the national and sub-national level.

> P04 *"..There are less commitments from private sectors, organizations…" "..the greatest challenge is that I found it difficult to convince them…", and "…sometimes they fail to convince their top management… "*

On the other hand, some success was reported with a government-established competitive model for fleet companies, involving the potential award of an official certificate in recognition of success in reducing road crashes in their fleet.

Lack of road safety management and partnership was raised, with some participants feeling that involvement from relevant partners and the National Road Safety Council has been limited.

> P11 *"Cambodia has more resources than other countries that I know, but they are not coordinated"* and *"…Road Safety council or committee in Cambodia, but it does not have the power to dictate to the different groups and to coordinate in different groups in an effective way…"*

A problematic hierarchy of responsible authorities was considered to be another important obstacle for speed management in Cambodia. Many national and rural roads have been recently improved and paved, but there is no enforcement at district level and effectively none at commune level. Several participants pointed out that commune police officers do not have authorization to enforce traffic laws in their communes, since only traffic police officers have authorization to enforce the law and there are no dedicated traffic police officers at the commune level. To gain authorization, commune police need to ask approval from their management at the district and provincial level and then the enforcement must be approved by the governor.

> P09 *"..If they want to enforce the law, they need to ask approval from district and provincial level."*

This has relevance to the general deterrence requirement of a high perceived risk of detection. Some participants pointed out that speed enforcement is conducted only on national roads and one stated that speeding is not enforced in Phnom Penh. Furthermore, it is enforced only during the daytime, as at night there is insufficient light along the roads so the detector on the camera reportedly does not work well. Nearly half of the participants said speeding is not enforced regularly.

Another potential issue is political influence. It was pointed out that the government cancelled the requirement for a driving license to ride a motorcycle 125cc and under, apparently for political reasons. It is also customary not to enforce traffic laws six months before and after the election.

> P09 *"…After the announcement of no need for a driving license for under 125cc, there is a good chance that young drivers will drive motorcycles without a driving license…it is a mistake to allow them to drive without learning about the law, which leads to speeding"*

The concept of corruption remains a potential challenge for a speed management program in Cambodia. Four participants were concerned about corruption in law enforcement and program activities. One participant pointed out that some drivers obtained driving licenses without a test. Another felt that offenders could use money to address their illegal actions which reduces respect for the law. Presumably the return of 70% of fines to police officers should address this issue, which suggests that there may be some other issues at play that facilitate corruption (e.g. a non-financial benefit gained by police for a bribe that is lower than the return from the fine).

> P08 *"Example, the fine is 50,000 Riels…if drivers pay 50,000 Riels, they have a receipt from traffic police officer… If there is any negotiation with police to pay just 5,000 or 10,000 Riels, then police will accept…"*

Lack of infrastructure support for speed enforcement is another potential issue. Most participants (8 out of 13) pointed out that there are no effective means of sending automated speed enforcement tickets to offenders' homes because vehicle ownership data is not accurate. One participant reported that for penalties where the ticket was sent to the recorded address of the vehicle owner, only 20% paid, 30% avoided the fine (presumably be presenting evidence that they were no longer the owner), and 50% could not be found at the address. These issues are being addressed, with the implementation of a QR code for vehicle plate number and driver identity, and upgrading the vehicle registration system so it can be linked to databases in other departments to support the process of penalty administration. There are issue with other databases as well, such as the recording of previous offences.

> P11 *"..if you speed today, if I caught you speeding again tomorrow, there is no database to show that you have been caught yesterday or 10 times in the last month."*

Most participants pointed out that there are insufficient human resources for enforcement, and a need for capacity building to implement speed management at both national and sub-national level. There is a lack of budget for training, and traffic police work long hours and often do not get invited to attend training. When training is provided, it is general rather than dedicated to speed management, and there are very small numbers of police at district and commune level anyway.

> P08 *"…Traffic police officers have other duties, they are not assigned to work only for road safety, I think they may lack human resources."*

It was mentioned that many speed cameras have been purchased and this has been beneficial, although the number of cameras may not be enough to support expansion. There are plans to install red light/speed cameras at some traffic lights, but this was the only measure mentioned that related in some way to road infrastructure, apart from concern that road construction standards were compromised because contracts went to the lowest bidder.

The length of time taken to gain approval from the government is another barrier for improving speed management in Cambodia. This applies to infrastructure programs, campaigns, and also legislation.

> P11 *"In Cambodia it takes about three years to get legislation change…. in Australia because if you want the legislation change it can be done in 12 months.."*

A more concerning aspect of legislation relates to its implementation, which affects the general deterrence aim to have high perceived severity of penalties and certainty the penalty will be administered. As flagged in the previous section, the points system that was described in the secondary source analysis, whereby offending drivers have points deducted from the 12 they are allotted for a three year period, has not been implemented. Since mention was made of plans for legislation to enable implementation, and therefore a further delay, this suggests that there are complexities to legislation and/or legislative processes more generally that need to be addressed.

Social and cultural factors

Limited knowledge and understanding of speeding and speed enforcement are potential barriers in this area. Almost half the participants considered that road users and drivers have limited education and knowledge related to speeding, the traffic law and law enforcement. As noted in the discussion of secondary sources, this is consistent with survey evidence. When asked about reasons for speeding, most participants said drivers are in hurry, do not know about traffic law and traffic signs, law enforcement is low, and they may be using drugs (especially fleet drivers).

Cambodia is a Buddhist country (around 95% of the population), and belief in karma and reincarnation are part of this, i.e. that negative events (like a traffic crash) are experienced because of one's actions in a previous life (Sann, 2017). This is an issue for promotion of safe behaviours, as it is linked with the view that safe behaviours will not help to avoid karma, and incidents where people do the right thing but are still killed or injured are taken as evidence that karma is more important, as are multiple incidences of unsafe behaviours that do not result in negative consequences (King, 2005). When asked about driver behaviour in relation to karma, there were mixed views about whether this was due to genuine belief in karma, lack of knowledge, or a generational issue.

> P09 *"It is a kind of belief in the previous generation. … So, we can't reject that they don't believe in that…"*

Notably, it has previously been found that educated informants in a similar society (Thailand) expressed the same doubts, whereas less educated Thais of all ages showed a strong belief in karma as an explanation of road crashes (King and King, 2006). This is a form of fatalism, which is found in all societies, although they differ on what kinds of outcomes cannot be influenced by safety behaviours, which suggests that public education should aim to align road safety outcomes alongside other outcomes that can be influenced by taking appropriate action (Kayani, King & Fleiter, 2012), in this case compliance with speed limits.

The Culture of Facilitation (CF) or VIP Treatment is another challenge for speed enforcement. This refers to the process whereby offenders try to avoid punishment using their networks, relationships, or power to negotiate with traffic police officers. This similar to the Chinese concept "guanxi" involving the use of personal networks, social capital, and gift economics (Gold, Guthrie, & Wank, 2002) to avoid enforcement and punishment, which negatively influences community perceptions of the fairness of law enforcement (Jia, Fleiter, King, Sheehan, Ma, Lei & Zhang, 2016) and undermines the development of a culture of compliance with the law (Sinclair, 2013). Although the practice has been reduced in Cambodia, nearly half of participants pointed out that it is still practiced when the law is enforced. It weakens trust in police and law enforcement in general. It is also relevant to the general deterrence requirement of a high perceived certainty of punishment of detected breaking the law.

> P11 *"There is also a major problem in Cambodia with VIP treatment because many of those people who hold position or power in the government or in various areas maintain that they are exempted from being penalized or fine, so that is the big problem for the police that are abused the power which is a major consideration"*

There were other issues of less direct relevance to speed management, such as the unavailability of young males for event-based public education (though this does not apply to mass media) and the practice of failing to stop after a crash because associates of a victim may attack you (examples have been filmed and posted on social media). The "hit and run" practice has become embedded in professional driving practice, where truck or bus drivers employed by fleets are directed not to stop and let the insurance company manage the case.

Recommendations

In the Introduction a brief summary was presented of the GRSP (2008) list of tools required for effective speed management. The first of these is a road hierarchy based on function, in rural and urban areas, however there was no mention of such a hierarchy in connection with speed management in the sources consulted. The legislation on speed limits only makes a distinction between "cities/towns" and "elsewhere". The importance of this becomes apparent when considering the next tool, *appropriate speed limits (based on the Safe System approach) that are clearly signed*. The explanation provided in GRSP (2008) makes it clear that the factors involved in setting speed limits are strongly based on road design and road features, as well as the traffic mix. However, Cambodia's are based only on the type of vehicle within the roads/cities vs elsewhere distinction, which takes no account of the comparative mix of the vehicles, the function of the roads, their design or conditions. This makes it very difficult to implement a Safe System approach to speed management.

The need for clear signage recommended by GRSP is also affected by the multiple speed limits that apply to different vehicle types. Strong consideration should be given to reducing this complexity, which ties in with the first part of the next tool, *effective laws and regulations supported by effective enforcement and adequate penalties*. There were examples given by key informants of deficits in administrative databases that prevent some laws and regulations from being enforced effectively, in particular the inaccuracy of the data on vehicle ownership and the owner's address. This is very important for automated speed enforcement, a direction in which Cambodia has been heading. There was information that this deficit is being addressed, and it is important that such improvements are indeed implemented as fully as possible.

Comparison between Queensland and Cambodian fines for speeding, based on PPP, indicate that penalties in Cambodia are relatively lower and could be increased. Information from key informants was that the integrity of enforcement was open to question due to reported bribery and influence

(Culture of Facilitation and VIP Treatment). The extent to which this is rumour or reality needs to be ascertained, and any necessary action should be transparent, to build confidence in police integrity. A more difficult issue is the current arrangement by which 70% of fines are returned to the police who issue them. This reduces the temptation to take bribes, but could distort enforcement activity towards offences with a combination of value and frequency that optimises benefits to the police officers concerned. The other important penalty aspect is the points system, which has not been functioning. It is promising that this is apparently being addressed, though its effectiveness will also rely on the accuracy and timeliness of data recording.

Effective enforcement using a general deterrence approach involves sufficient intensity and visibility to give the impression that enforcement can occur anywhere at any time. The interview information suggests that there are several issues that need addressing to achieve this. There is reported to be almost no speed enforcement at provincial and commune level, through a combination of limited resources and onerous processes for gaining approval for police at these levels to conduct traffic law enforcement. Even in cities and towns, enforcement typically does not occur at night, and it appears that traffic police numbers are limited, which both constrains enforcement and prevents police from receiving adequate training. Lack of funding has hampered the purchase and use of automated speed enforcement technology, and previous funding from NGOs has not been replaced. Finding additional resources is challenging, but could be addressed through negotiation of development priorities with funders.

The effectiveness of enforcement is known to be interdependent with *public education about the risks of speeding, and to support enforcement activity*. The surveys considered in the secondary source analysis showed a lack of knowledge about speed limits and speed signs, which is related to the issue of the complexity of current speed limit legislation. The interviews that mentioned public education referred mostly to event-based programs (getting groups of people together) which tend not to involve young males. A systematic approach to public education that ties together considerations of target groups, target behaviours, appropriate channels, credible and appropriate messages (e.g., addressing fatalistic beliefs), and support for enforcement activities is required.

The main point mentioned relevant to *installation of low/medium cost engineering treatments to reduce risk* was the use of delineated motorcycle and bicycle lanes. Such lanes are apparently intended to be in place, but are not well delineated and ignored by road users. To some extent the need for such lanes is tied to the differential speed limits by vehicle type, and to some extent it recognises different degrees of vulnerability of road user types. The policies and practices for such lanes need to be reviewed at the same time consideration is given to reducing the complexity of the seed limits and implementing a road hierarchy explicitly based on function, road design, road features and traffic mix. It may be that fully separated lanes for bicycles and/or motorcycles would be advisable for certain road functions. The use of roadways by pedestrians also needs attention, although this requires a combination of provision of footpaths, regular maintenance to make repairs and clear debris, and enforcement to keep paths clear of parking and businesses.

New vehicle technologies were not mentioned in secondary sources or by any informant, and are likely to entre the fleet through market processes unless the government takes the initiative to require certain technologies to become more widely available. This could also happen as part of *workplace health and safety legislation and management to reduce work-related driving risk, especially for freight vehicles*. The key informants and secondary sources did not address work-related driving directly, although the results of the survey reported by Tun (2015) implied that commercial vehicles (including buses) were more likely to speed. A structured approach to commercial driving safety would have wider benefits in addition to reduction in speed-related crashes.

An important need that is not mentioned among the GRSP tools is data to enable monitoring and evaluation of speed management. One of the criticisms of speed management in Australia was the lack of information on travel speeds over time, and the lack of reliability of data on speed-related crashes. It has been noted that Cambodia's RCVIS is not as accurate as it once was, and the WHO estimates of total fatalities in Cambodia are significantly higher than the RCVIS figure. It is important to address these points, if possible. Since this involves several agencies whose coordination was reported to be lacking, an effective Safe System approach will depend on this coordination being improved.

Conclusions

Implementation of best practice speed management is challenging for HICs, and even more so for LMICs like Cambodia. An analysis of the context of speed management in Cambodia, using secondary sources and key informant interviews, indicates a number of challenges that would need to be addressed. There is a need to introduce a road hierarchy based on function, and to change the speed limit legislation from a complex vehicle-based scheme to a road hierarchy-based scheme. Road users need to understand what the speed limits are, what the penalties are, and that there is a high chance of being detected anywhere at any time (the reality of which also needs to be ensured). They need to be certain that penalties will be administered impartially and with high certainty, and the penalties need to be sufficiently high to deter offences.

A macro level issue concerns the funding available for policing, training, equipment and campaigns; and legislation and processes that support rather than hamper the delivery of enforcement at a high enough level, across locations in rural as well as metropolitan areas. This funding support is likely to be necessary to ensure that the data systems that support and enable speed management operation, monitoring and evaluation are accurate and reliable and up to date.

Overall, pursuit of a Safe System approach to speed management needs to be coordinated across the relevant agencies

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Contributed Articles

Road Safety Policy & Practice

Road safety lessons to learn from Low and Middle-Income Countries

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Key Findings

- Political will is an essential component of road safety reform, however, needs to be holistic in approach to ensure sustainability
- Road safety issues in all countries are similar, however, there is a matter of scale in fatality ratios, population, traffic mix and traffic density
- Successful programs in one country can be transferrable to another country, with relevant modifications
- NGOs are effective as advocacy groups in low and middle-income countries
- Youth empowered organisations can provide powerful advocacy in road safety reform
- Road safety lessons can be learned from low and middle-income countries

Abstract

This paper presents aspects of policy and practice observed in low and middle-income countries (LMICs) and the lessons which can be learned from these and similar initiatives. The role of non-government organisations in capacity building programs and advocacy is identified as a strong foundation for road safety reform. Political will is discussed as a critical component of reform together with the need for a holistic approach to ensure sustainability. The requirement for a strong evidence-base to support evaluation is discussed and the need to ensure strong governance over law enforcement is profiled. Good practice programs are described as well as the importance of harnessing the enthusiasm and dedication of youth in developing and championing initiatives for safer community outcomes. While the lack of resources and financial support may appear as an impediment to some, if viewed as a surmountable challenge, safety outcomes can be achieved. The findings demonstrate that there is a rich environment in LMICs from which to source and undertake key and critical research to stimulate continuous road safety improvement especially in those countries where road trauma remains at a comparatively high level.

Keywords

Knowledge transfer, road safety lessons, advocacy

Glossary

ACRS. Australasian College of Road Safety
AIP Foundation. Asia Injury Prevention Foundation.
GRSP. Global Road Safety Partnership
HIC(s). High-income country(ies)
LMIC(s). Low and middle-income country(ies)
NHMP. National Highways and Motorways Police
NGO(s). Non-government organisation(s)
RMTO. Road Maintenance and Transportation Organisation
RS10. Road Safety in 10 Countries. Brazil, Cambodia, China, Egypt, India, Kenya, Mexico, Russia, Turkey, Viet Nam,
WHO. World Health Organisation

Introduction

"There is always something to learn from everyone you cross paths with." This general adage attributed to Edmond Mbiaka can be equally applied to inter-jurisdictional knowledge-transfer in road safety initiatives. Road safety advocates internationally draw upon research, demonstration projects, evaluation studies and proven initiatives, usually from high-income countries (HICs) to stimulate continuous improvement in road trauma reduction.

Research regularly assesses specific or global road safety issues in low and middle-income countries (LMICs) and acknowledges the lack of evidence-based solutions. Recommendations may conclude with the need for more data analysis, more enforcement, more advocacy and more research without prescriptive advice on how to instigate road safety reform (Jacobs, Aeron-Thomas & Astrop, 2000; Abdella, Kibogong, Bartolomeos & Mwai, 2016; Dhibi, 2019). The challenge is to garner practical solutions from practitioners, operatives and research bodies in those countries and promote solution-based research.

The Australasian College of Road Safety (ACRS), over recent years, has fostered scholarships and conference presentations on road safety research and evaluated initiatives from LMICs. Sharing of information is traditionally considered valuable for other countries in similar circumstances of high population density, limited resources, and a lower socio-economic environment. Most of the current road safety intervention research originates from HICs with proportionally few from LMICs despite these areas bearing the greater injury burden (Perel, Ker, Ivers & Blackhall, 2007). However, there is value in reporting some observed LMIC initiatives not previously the subject of evaluation or peer review and which may have relevance in both HICs and LMICs.

The focus of this paper is to identify from the authors' experiences, a sample of practical initiatives specifically from LMICs and provide the stimulus for practitioners with similar observations to undertake and present research with evaluated outcomes to add value to the international knowledge on successful road safety reform. Some key issues examined include the power of NGOs, political will, youth empowerment, governance, technology, and the ability to achieve road safety outcomes with limited resources.

Methodology

This paper presents aspects of road safety policy and practice identified by the authors in our experiences, observations, and perspectives specifically while working in LMICs over many years. Examples of good practice are provided and combined with relevant research aligning with some of the initiatives and programs. While no actual evaluation has been undertaken by the authors, the richness of available material highlights the potential in LMICs for others to undertake valuable studies to add to the current body of road safety and intervention models.

It is important to note that this paper has focussed on human behaviours and advocacy as components of the Safe System Approach while appreciating that other components of road infrastructure, vehicle design and emergency medical response all contribute to making roads safer. Initiatives in all disciplines may well provide a rich source of research.

It is further acknowledged that the samples provided represent a limited catchment area internationally and there are many other examples where initiative is demonstrated in the face of resourcing and financial restrictions. This limitation does not detract from the observations, but rather indicates a prospective environment from which local and international researchers may undertake in-depth studies and critical evaluations. It is notable that we, the authors, were participants or observers in the programs and activities described or meetings and conferences discussed.

The foundation for good practice in LMICs

In 1999, as an early impetus for globally advancing road safety in LMICs, the World Bank established the Global Road Safety Partnership (GRSP) as one of its four Business Partners for Development initiatives based on public-private partnerships for its development approach (Bekefi, 2006). Hosted by the International Federation of Red Cross and Red Crescent Societies, GRSP is a membership-based organisation that aims to foster road safety excellence through encouraging governments, businesses and non-government organisations (NGOs) in LMICs. The idea is that governments are responsible for public safety, businesses have an interest in safety and management capabilities, and NGOs have the energy and motivation to act at a community level. Combining these attributes serves to boost the effectiveness of road safety efforts.

The World Health Organisation (WHO) has established a network of Collaborating Centres for Injury and Violence Prevention in all WHO Regions supporting the development of the Global Status Report on Road Safety and the World Reports on Child Injury Prevention and Road Traffic Injury Prevention. These groups facilitate the development of training centres through TEACH-VIP, a modular training curriculum, the MENTOR-VIP mentoring program and by developing the global targets for road safety. From 2010-2014, with support from Bloomberg Philanthropies, coordinated activities were undertaken with GRSP in programs such as Road Safety in 10 Countries (RS10), providing training for good practice in education, advocacy, legislation reform and enforcement. Each of the 10 countries identified two major road safety risk-factors for concerted effort in road safety reform with all programs monitored and evaluated.

To this day it appears that it is often the case that NGOs are the active advocates of road safety in LMICs. The United Nations Road Safety Collaboration (UNRSC), in recognition of the effective road safety work of NGOs around the world

provided a platform for the establishment of the Global Alliance for NGOs for Road Safety, now boasting over 200 members operating in 90 countries and sharing good practice internationally.

Road safety programs, whether led by governments, businesses or NGOs, are more effective if they are based on data analysis and scientific research. This is why universities and research centres also have a key role. For example, the Bangladesh University of Engineering and Technology (BUET) has undertaken road safety research that has underpinned the most effective road safety programs in Bangladesh. The Malaysian Institute of Road Safety (MIROS) provides a similar function in Malaysia and contributed leading international research through the development of the perception index. This index identifies the correlation between driver attitudes and behaviours where the best results will be achieved if the perception of the risk of being caught and punished is high.

Practical Examples of Road Safety Innovation

Examples from Iran, Cambodia, Viet Nam, and Pakistan have been selected to illustrate policy and practice approaches undertaken to achieve road safety outcomes. Key strengths for these initiatives are highlighted for each country. Further examples are provided from Indonesia, Cambodia, Yemen, Iran and the Philippines to show initiative and innovation in the face of resourcing barriers and impediments.

Islamic Republic of Iran – Tackling the challenge of speed management

In response to the identification of rapidly rising road trauma, a World Bank mission in 2005 undertook an appraisal of road safety in Iran. Seven international experts reviewed statistics, travelled the country and consulted senior government and policing officials. The resultant National Road Safety Action Plan facilitated the transfer of knowledge, technical assistance, equipment purchases, institutional development, and innovative solutions.

Figure 1 depicts road trauma trends rising sharply from 2001 to a high in 2005 of 27,746 fatalities, then progressively and dramatically reducing to 15,922 by 2016 (-43%). Subsequent research studies refer to new legislation, new roads and speed control, however have not identified particular initiatives leading to the reduction, but rather focus on recommendations for further reductions (Bahadorimonfared, et al., 2013; Salari, Motevalian, Arab,

Figure 1. Iranian fatalities 2001-2017. Source Road Maintenance and Transportation Organisation (RMTO) Iran

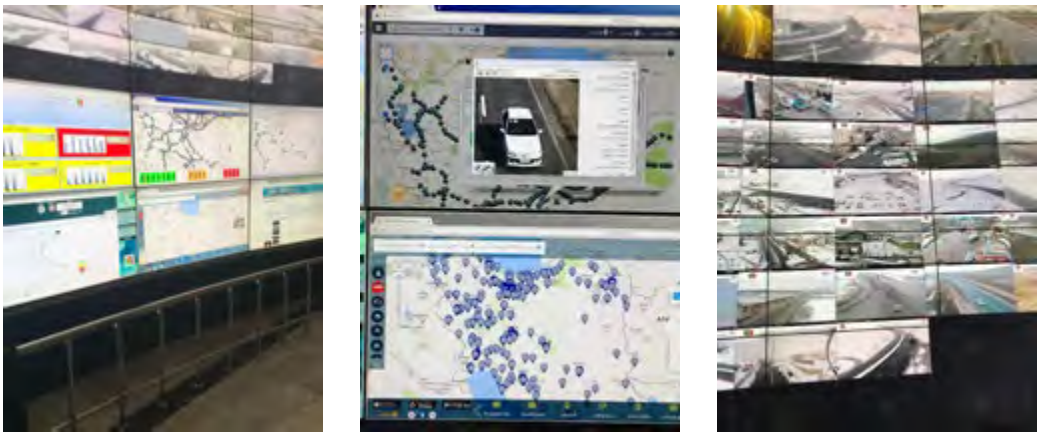

Figure 2. Control room, Traffic Management Centre, Tabriz, Iran.

Esfandiari & Akbari Sari, 2017; Razzaghi, Soori, Kavousi, Abdi & Khosravi, 2019). An observational perspective is that an increase in divided highways, avoiding head-on collisions, speed controls and intelligent transport system initiatives may have contributed to the substantial decrease in fatalities.

The Iranian government's commitment to speed management was applied to traffic police enforcement with the purchase of 100 speed guns in 2003 and progressively increased police equipment to the current 1,112 portable police operated video cameras. It is noteworthy that video speed enforcement cameras are not common in Australian police enforcement equipment. In addition, there are 2,300 enforcement cameras installed throughout Iran, 1,800 of which are spot speed cameras. In May 2014 point-to-point average speed cameras were progressively introduced. There are 731 CCTV monitors across the network, as well as 32 weigh-in-motion devices which also measure speed. 203 variable message signs are used to vary speed limits.

These speed cameras are complemented by a modern control room, monitoring cameras in real time and sending texts to speeding drivers *immediately* an infringement is detected. The police receive a similar notification, validate the infringement and send a second notification by text and a fine to the offending owner. The text notification is to immediately inform drivers their speed is being monitored. Figure 2 depicts the real-time enforcement processing in the Tehran control room. This initial processing far exceeds current HIC practices. The control rooms are replicated on a smaller scale in some Provinces.

The effectiveness of the speed camera technology is being monitored in various programs whereby the average driving speed is measured up to 600 metres before and after each camera site. Throughout Iran, warning signs are posted approximately 1 km before each camera site. An example is provided in Figure 3, where vehicles are demonstrated to slow at the camera sites with standard speeds being resumed following the camera site. This information is used as a

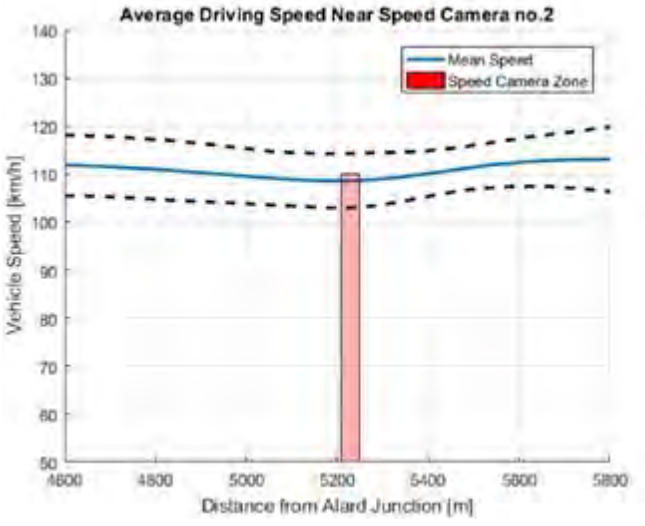

Figure 3. Graph courtesy of the Non-communicable Disease Research Centre, Tehran 2019.

catalyst for increased point-to-point camera technology and speed reduction strategies. This is an obvious, however, neglected tool in HICs evaluation protocols.

Notwithstanding, the success of the initial focus, speed remains an identified risk-factor attributed to 16% of crashes and 22% of severe injuries and fatalities in 2019. The statistics are believed to be higher due to poor quality of data, the data collection form, and the reporting mechanism. In recognition of the important role of speed management in the Safe System approach to road safety, the RMTO requested WHO assistance to review and strengthen speed management in Iran, particularly in the rural road network. An outcome of this review was the decision to initiate a new program involving three pilot sites to trial speed management approaches to guide wider speed management programs for Iran and other countries in the WHO Eastern Mediterranean Region. Two of the authors (RS and LM) are part of an international team advising on the Safe System implementation and guidelines as well as improvements to streamline the enforcement strategies and processing to ensure a holistic approach to speed management.

This example demonstrates an achievement resulting from dedicated global health body and Government actions focused on speed as a major risk factor while acknowledging the need for continued application of interventions as now being applied consistent with the Safe System approach.

Iran's Intelligent Transport System – A fatigue management intervention

A leading-edge Intelligent Transport System (ITS) is being progressively introduced to improve the safety and efficiency of Iran's freight and passenger road transport fleet. *The Smart Fleet Traffic Monitoring Car System* uses the vehicle's electronic control unit and global positioning system, as well as a special camera in the driver's cabin, to provide pre-defined protocols to the police monitoring system. Hours of driving, speed and travel information are electronically transferred to police patrol bases. The plan is to install 368,000 units in vehicles throughout Iran. Our team observed this system in operation, including the reporting to police patrol locations, while being transported on intercity buses. Figure 4 depicts the unit being activated by the driver with his unique identification licence, the camera in situ and a police reporting facility.

Another ITS fatigue management intervention observed was developed by Tehran University and trialled in the Bus Rapid Transport system whereby the steering behaviour and other parameters of the vehicle are monitored from the central base. Drowsiness, texting, reading or other distractions can be identified through electronic monitoring of the steering wheel. When abnormal behaviours are identified by the monitoring system, an electronic signal is transmitted initiating a judder/shake to the steering wheel to gain the driver's immediate attention. Repetitive occurrence results in the driver being contacted to cease driving.

The identification of these initiatives provides a rich source for research to identify their collective impact on road

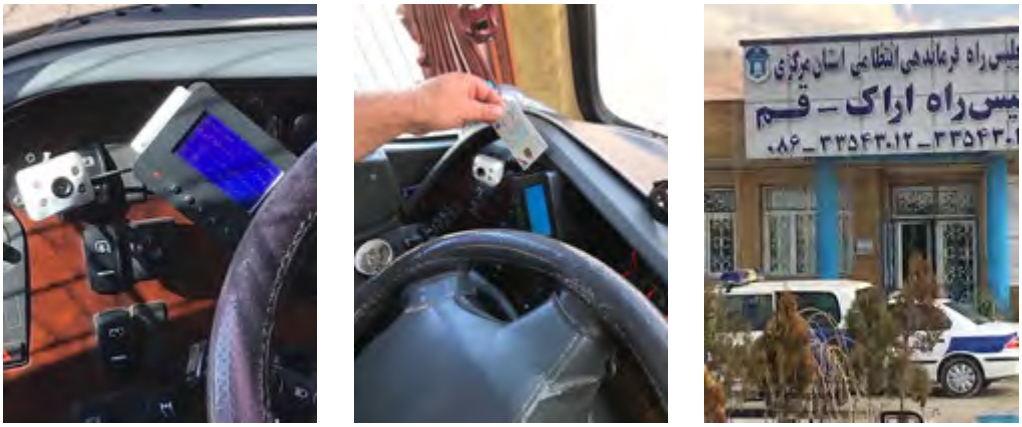

Figure 4. Intelligent transport system monitored by police

trauma reduction in Iran, as well as providing real time road safety management devices.

Cambodia – Youth empowerment and peer influencers

Youth empowerment programs are a feature of road safety initiatives in Cambodia building a culture of responsible behaviours among road users. Together, youth are perceived to be the best agents to spread the information and advocate for better policies, legislation and prioritised interventions of roadside and social enforcement in their respective communities. Two of the four major youth organisations are described.

CAMSAFE engages youth in a 12-week capacity building training program to then transfer knowledge, inspirational awareness and peer influence to primary and secondary students, their parents and villagers to collectively build road safety knowledge. Programs range from constructive fun activities for children through to focussed messages on speeding, drink driving, pedestrian safety, helmet use as well as hands-on cyclist and motorcycle training. Cambodian law does not require training or licensing of riders of motorcycles of 125cc capacity and below, an issue long concerning advocacy groups as young male motorcycle riders are the high-risk group in road trauma. Youth groups are proactively addressing this omission. Figure 5 illustrates a range of programs provided by CAMSAFE from fun

Figure 5. Camsafe youth: A collection of program initiatives

Figure 6. Youth Ambassadors for Road Safety, Cambodia

activities, partnership activities with police to motorcycle rider training.

AIP Foundation's Young Ambassadors for Road Safety (YARS) has empowered youth with road safety education and skills, to serve as positive role models and advocates. This has enabled the education of thousands of university students on key road safety topics and major risk factors leading to broader community change, road safety action plans and social media campaigns. Youth ambassadors participate in national road safety conferences, street-based education campaigns and specific speed awareness programs at bus stations and transport companies. Other activities range from hosting educational road safety activities at primary schools to working with traffic police on national highways providing a youth perspective of effective road safety strategies to promote safer road safety behaviours among their peers.

YARS influence has enabled meetings with the National Road Safety Committee, National Police, the Ministry of Education and other government bodies. Empowerment at national level initiated a call to action during the 2017 Global Road Safety Week to *'Save Lives, Slow Down'*, a commitment endorsed by 17 major local and international organisations. Figure 6 depicts youth working with police, young children and for motorcycle safety. Within Cambodia, these groups are presenting as powerful advocacy groups for road safety reform. They have a strong voice with policy makers, peers and vulnerable groups as they operate to assist in achieving the targets set under the Sustainable Development Goals 2030 by saving lives in road trauma reduction, improving livelihoods, reducing poverty and to scale-up social equality and economic development.

Viet Nam 2007 – Government support (political will) for helmet-wearing

The history of helmet wearing in Viet Nam provides an example of where concerted political action, complementary to legislation, was the catalyst for national behavioural change overnight on 15th December 2007.

The proliferation of motorcycles and their vulnerability in crashes was a major contributing factor in the high rate of fatalities and serious head injuries in road trauma in Viet Nam. Official road fatalities were 12,800 and considered to be under-reported by 30% (Anh & Dao, 2005; Pervin, Passmore, Sidik, McKinley, Nguyen & Nguyen 2009). Helmet-wearing on national highways and main roads was mandated by law in 2001, however, the compliance rate was at best 30% during the day and negligible at night. The strong resistance from riders to wearing uncomfortable "rice cookers" combined with the lack of any strategic enforcement, reflected the impotency of the law.

A GRSP and AIP Foundation sponsored workshop with international and national experts in December 2006 concluded that a major impediment to national change was

Figure 7. Hanoi, Viet Nam following mandated helmet wearing from 15th December 2007

the Vietnamese socialist structure requiring consensus from the 58 provincial leaders with a potential delay of at least 2 years. The real impetus for change was the attendance of the Transport Minister and Vietnamese Delegates at the Road Safety Summit and Asia-Pacific Economic Cooperation (APEC) meeting in Adelaide, Australia in March 2007. Road and transport safety, and tropical helmets were high on the agenda. Ministerial Declarations 51 and 52 urged ministers to focus on the key risk factors in their national road safety plans.

On 29th June 2007, Resolution 32 of the Vietnamese Government decreed that all motorcycle riders and passengers were mandated to wear a motorcycle helmet on all roads from 15th December 2007. The promotion and preparation for this day was of national significance with marketing, education programs, training in enforcement strategies and strong support from all sectors for this enigmatic implementation date.

Observations of the transition from 14th to 15th December were remarkable. Overnight the wearing rate went from 1 in 12 to almost 100%. Figure 7 depicts the change to mandated helmet wearing in Hanoi. In Ho Chi Minh City alone, serious traffic injuries fell by almost 50% compared with pre-helmet weekends (WHO, 2007). Research suggests that this law saved more than 1,500 lives in the first years and reduced head injury trauma cases by 2,500 (Enserink, 2014). This impressive behavioural change demonstrates government commitment and political will to achieve a positive road safety reform. It followed nine years of lobbying by many NGO's and partner organisations.

However, rigorous enforcement was not sustained, and helmet wearing rates dropped with the police maintaining they hadimplemented the enforcement package and therefore the community should know what to do and comply (Shuey, 2018). Additionally, the government delay in enforcing quality standards enabled the market to be flooded with fake, poor quality helmets as a cheap head covering rather than a legitimate head protector for welfare and safety. This example from Viet Nam addresses three factors in road safety, namely, the essential component of political support, the need for a holistic approach to interventions and the need to ensure the sustainability of any interventions.

Pakistan – A governance approach to effective and respected traffic law enforcement

A significant concern is traffic enforcement corruption,which exists in all parts of the world, but is of greater importance in LMICs because it harms the effectiveness of public agencies (Van Eeden Jones & Lasthuizen, 2018) and reduces trust that police are administering justice fairly (Mazerolle, Bennett, Davis, Sargeant, & Manning, 2013). Such corruption can take many forms, though common types are bribes (typically a driver pays a bribe smaller than the fine) and use of influence (the driver's own status, or their links to influential individuals or organisations). The relatively low pay levels for police in LMICs, coupled with the greater practical difficulty for drivers of paying a fine (which may involve losing a day of work to wait in line), creates an environment where bribery is in the interest of both parties. The use of influence is fostered by a strongly hierarchical society, which is found in many LMICs. In other words, governance characteristics, social structure and economic conditions contribute to a higher likelihood of ineffective traffic law enforcement and lack of respect for police.

Figure 8. NHMP officers conducting enforcement, Pakistan

Prior to 1997, policing of traffic law in Pakistan was considered to suffer from these problems. However, 1997 saw the establishment of the National Highways and Motorways Police (NHMP) (Figure 8) responsible for policing the national highways and motorways (Perito & Parvez, 2013). NHMP now conducts enforcement on 39 national highways, motorways, expressways and strategic routes, of just over 12,000 kms; although this is only 4.6% of the road length in Pakistan, these roads carry 80% of Pakistan's commercial traffic (NHA, n.d.).

Kausar (2005) outlines the planning and training of the NHMP at its inception, noting that the following objectives were established:

- To control violations on the Motorway as well as the National Highways
- To ensure safety and to provide assistance to road users
- To curb crime on the Motorway and the Highways
- To launch the road safety campaign to create awareness for the motorists
- Commitment to give due respect to all road users and be fair and firm and uphold ethical practices on all occasions
- To discourage VIP culture
  (Kausar, 2005:1)

The last two of these objectives directly address the aims of fair and just policing. It is interesting to note that although the recruitment of NHMP officers was initially selective, it appears that many were ordinary police deputised to join the NHMP, and according to Kausar (2005:2) *"many … were average or even below average"* and *"some of the officers…(had) previously engaged in malpractices"*. The turnaround in their performance and integrity was attributed to a *"conducive work environment, good training and proper incentives"* (Kausar, 2005:2).

During its operation, the NHMP has been consistently highly rated by Transparency International in terms of freedom from corruption, at the same time as the Pakistan Police and Judiciary has been rated as one of the most corrupt agencies in Pakistan (Khoso, 2015). This suggests that there is something special about how the NHMP was established and how it continues to operate.

At the operational level, standard operating procedures were established to guarantee uniformity and clarity, service-oriented policing was emphasised, crash data were used to ensure that enforcement was intelligence-led, and police activity was confined to moving violations with no seizure of documents.

Some key elements that relate to the creation of an environment less conducive to corruption were:

- Very good working conditions, including:
  - An attractive package with special allowances, and bachelor accommodation or a rent ceiling
  - One-step promotion on joining NHMP and input into choice of posting
  - Free medical treatment, access to healthy food, uniform
- Official highlighting of the booking of VIPs for traffic offences

Not only did this approach lead to the NHMP being acknowledged as one of the least corrupt police forces in LMICs, this performance has been maintained for more than 20 years, demonstrating that the approach has been sustainable. The focus on culture and developing a work ecology that fosters police integrity and fairness have set the basis for effective deterrence of traffic offences and therefore a reduction in crashes.

General road safety innovation in the face of resourcing limitations

The lack of financial support and resources is sometimes presented as an impediment to road safety reform and productive interventions. Advice from interactions in LMICs and observations are that resourcing restrictions often provide inspiration for initiative.

In Surabaya Indonesia, police operated point-to-point traditional speed enforcement over 1 km on a national highway with a high casualty rate. An officer at the commencement point radioed the start time and vehicle identification through to the control checkpoint measured at exactly 1km. The distance and time were converted to average speed and the driver stopped and sanctioned. Officers reported successful speed reduction on that section of highway.

In Cambodia where children are required to cross a busy national highway to go to school , teachers and children used 30 metre ropes across the road forcing **all** traffic in both directions to stop, thus providing a safer corridor crossing for groups of children. The schools reported the risks were minimised and the supervisors had achieved a higher level of safety for the children.

In Yemen in 2010 before the crises of war, where a new main highway separated the town and the school where 200 children had to cross twice daily, the local police and villagers would use rudimentary equipment to build a makeshift underpass to allow safe thoroughfare for the children. Additionally, in many village entrances, the villagers themselves would build their own speed humps to slow the speeding traffic prior to entering areas of high pedestrian density. These actions, while basic, were taken in the absence of official remedial action by road authorities.

In Cambodia, following the implementation of breathalysers and the requirement for certification every six months, police developed their own laboratory for testing and recalibrating the fuel cells at minimal cost. A similar certification program in Viet Nam had the requirement for University-based calibration at a cost of USD$100 per unit.

As a component of the 24th International Conference on Safe Communities in Tabriz, Iran, 2019, international and local expert speakers were individually video recorded in a studio as part of a 'virtual conference' with the agenda

and recordings circulated to all Iranian universities, thus exponentially multiplying the benefits of the original conference.

Many LMICs have made use of thousands of items of donated redundant but operationally effective equipment primarily from the Victoria Police, as well as VicRoads and the Queensland Police Service. Items include breathalysers, hand-held speed radar and laser equipment, analogue radio communications equipment, lighting, tape recorders and particulate respirator face masks. Facilitated by the International Safety Foundation, an Australian based NGO, recipient countries have included Bosnia, Brazil, Cambodia, Ethiopia, Lao PDR, Myanmar, and Nicaragua. As a tangible outcome, it is notable that the General Commissariat of the Cambodian National Police has graduated through these donations to now have purchased their own state-of-the-art tripod mounted video speed cameras.

An ACRS scholarship participant from the Philippines demonstrated in her presentation the power and opportunity of NGOs to save on the need for expensive advertising. Another of the participants from India advised in her presentation how social media was used to target audiences in a cheaper and more effective way.

These examples demonstrate by using initiative, financial and resource challenges can be overcome and successful outcomes achieved.

Discussion

Road safety policy and practice observed in LMICs are presented as concepts to share in our ever-challenging environment to save lives. Some initiatives have been developed by NGOs with a wide distribution network while others have developed locally through necessity. Each has value from which we can learn and foster a process of continuous improvement.

All countries are at varying stages of road safety development with different socio-economic, cultural, and political environments. Some programs may have universal application with common elements such as helmet and seat-belt wearing. Similarly, many countries have been slow to gain the full benefits with delays and resistance to legislative reform and enforcement actions for child restraints in vehicles and child helmet wearing on motorcycles. Another universal issue is speed management being a most difficult challenge in which to achieve behavioural change.

In each of the programs identified, there has not been any formal evaluation by the authors on the effectiveness or specific outcomes. They do however present on face value as interventions worthy of further study to prove effectiveness as road safety interventions.

Some general findings have been identified. The importance of commitment and political will at the highest level has been demonstrated by examples in Iran and Viet Nam, together with the need to ensure that the intervention is holistic in design and actions are maintained to ensure sustainability. The high-impact technological initiatives such as the Iranian speed and fatigue monitoring projects also demonstrate the need to undertake an holistic approach to the identified problems as well as demonstrating initiatives that could well be followed in both HICs and LMICs.

In LMICs, NGOs are effective in advocacy and have a key role in road safety reform. The importance of combining education and enforcement in practical applications is stressed as important components of road safety reform as well as the need for effective governance in the challenge for respect in law enforcement strategies. Further, youth groups which are empowered by training and coordinated activities can deliver a strong education and awareness profile and indeed be a powerful national lobby for reform activities.

General road safety themes are present across different countries. It is important to establish those themes and trends through crash data, local knowledge and general surveys so that focus can be applied to areas and targets of critical risk and where interventions may be applied. Each of the initiatives mentioned provide examples and benefits from which we can all learn. The importance of evidence is critical as a foundation for research evaluation and productive road safety reform. Key areas of separation between HICs and LMICs are in the scale of fatalities, population, traffic mix and traffic density.

While good practices and achievements in HICs are, and should be, shared with LMICs, the methods and interventions in these countries need to fit with their circumstances and resources. Many innovative approaches have been implemented in these countries. These may also contribute to good practices across all countries. Moreover, well-meaning offers of assistance from good practice HICs could be well-informed by learning about circumstances and practices in LMICs.

Conclusions

This paper has presented the authors' perspectives of aspects of policy and practice, describing various road safety initiatives in LMICs and confirmed the premise that there are lessons and learnings from a variety of programs in different countries. On a global scale the examples are a sample of NGO, county-based and individual initiatives, all targeting a universal concept of saving lives and making the world a safer place for generations to come.

All road safety practitioners and researchers are encouraged to report on their current activities and initiatives and share knowledge to both LMICs and HICs. The benefits in sharing experiences, knowledge and research manifests in continuous improvement in road trauma reduction, advances in road safety and our collective capacity to save lives.

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Features of Low-Income and Middle-Income Countries making Road Safety more Challenging

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Key Findings

- The road crash death and injury risks in low-income countries and middle-income countries are systematically higher than for high-income countries and deserve great global focus and resourcing.
- LMICs suffer significantly more vulnerable road user deaths, especially pedestrians, in part due to weak provision of pedestrian safety infrastructure.
- LICs and MICs differ significantly from each other on road safety and should not be treated as one group.
- Road safety performance also differs widely between countries with similar income levels, and this deserves further research attention.
- Despite the growing urbanization of human living, it is critically important that we also focus on rural road safety as well as urban safety with rural dwellers being at much greater risk of crash death than are urban dwellers.

Abstract

Low- and Middle-Income Countries suffer the large majority (93%) of global road crash deaths and face particular challenges in managing this crisis. This paper presents global data and trends revealing underlying features of the problem for LMICs. LMICs are commonly grouped and described together in road safety commentaries, yet appreciation of the substantial differences between LICs and MICs is vital. While global deaths per 100,000 people have stabilized during the UN Decade of Road Safety, the population rate has increased in LICs (by 8.2%), while decreasing in HIC and MIC. LICs have less resources to address road safety and younger populations adding to risk. Wide variations on road safety performance exist within country income groups, with some of this variance occurring systematically between regions. Absolute numbers of deaths are increasing due to increasing population and increasing vehicle fleets in LMICs compared with HICs. The capacity of MICs, and especially LICs, to manage road safety is hampered by poor crash data to guide action as well less available funding and resources to achieve safer road engineering, safer vehicles, and protect the large proportions of vulnerable road users. Road crash deaths and injuries are retarding the economic growth of LMICs and investing road safety is a cost-effective means by which LMICs can move towards becoming HICs. Vital opportunities for cost-effective savings of lives and debilitating injuries in LMICs include better management of speed (especially through infrastructure), improving safety infrastructure for pedestrians, increasing seatbelt use, and shifting travel from motorcycles to buses through provision of Bus Rapid Transit systems.

Keywords

Low-income countries, Middle-income countries, Speed management, Speed limits, Road safety engineering, Crash under-reporting, Safety barriers, Pedestrians, Motorcycles, Rural road safety, Urban road safety.

Introduction

Globally road crashes kill 1.35 million people and injure up to another 50 million each year (WHO, 2015, 2018). Although the population rate of death has stabilized at around 18.2 per 100,000 people (and slightly improved over the last 20 years: WHO, 2018), the absolute numbers of victims continue to increase as population increases. In addition, both the extent of the problem and the extent of progress are inadequately measured yet profoundly unevenly distributed. This paper briefly considers the scale of the concentration of the road safety crisis in Low- and Middle-income countries (LMICs), and presents data on the trends and features of LMICs which cause this concentration, as well as presenting the substantial differences between countries within income groups, and the systematic differences between LICs and MICs, which are too often treated together.

Relative Performance and Progress

In 2016 (the latest year for which WHO data are available), 93% of road crash deaths occurred in LMICs, up from 90% in 2013 (WHO, 2015, 2018). Table 1 shows the change in death rate per 100,000 people for each category of country income. These data identify the poorer and worsening of the population risk rate in LICs, in particular, highlighting the importance of considering LICs and MICs separately. People living in LICs have, on average, a 330% higher risk of dying in a crash compared with HIC residents, and 43% higher than MIC residents.

One interpretation of the poorer safety records of LICs, often advanced at political levels, is that for LICs to manage road safety they must first become HICs, and thus the focus of road development should be on higher speeds and improving economic efficiency of transport. A similar focus on increased speeds to improve the economy and reduced urban congestion is often apparent in HIC road transport policy, with road improvement decisions driven by travel time savings. These perspectives ignore fundamental evidence, which supports the following assertions. First, in many circumstances increasing speeds increase congestion (OECD, 2006), probably by expanding the gap (headway drivers allow) between moving vehicles. Furthermore, a faster journey yields a time gain typically erroneously perceived as large and far in excess of the objective time gain, which is in fact only marginal, especially for shorter trips (ETSC, 1995). Second, crash deaths and injuries create huge economic costs in HICs as well as LMICs. The costs of crash injuries and deaths represent deeply disturbing percentages of Gross Domestic Product (GDP) each year in all world regions, although these costs are highest in Africa (see Table 2). The economic importance of road safety is vital as part of the advocacy for investment. In LMICs these costs of crashes are shown to substantially retard long-term economic growth (World Bank, 2017). Thus, improving road safety is a means of helping LICs to become HICs, not vice versa. Third, road safety interventions regularly result in higher benefit cost ratios than other road engineering projects by reducing the costs of crashes, and in many cases (such as speed management) also reducing the costs of greenhouse gas emissions, air pollution, noise pollution and their health impacts (Sakashita & Job, 2016).

Within each income group road safety performance varies widely, supporting the value of sound road safety policy regardless of country income. Figure 1 shows the scatterplot of deaths per 100,000 people by GNI per person, demonstrating the wide range of road safety outcomes within income groups. Part of the variability is attributable to region. For example, MICs in Africa average 23.6 deaths per 100,000 people versus 14.4 for MICs in Europe (WHO 2018). Even among HICs the variation is wide, with HICs in Europe averaging 5.1 deaths per 100,000 people versus 11.4 for HICs in the Americas (WHO, 2018). The reasons for these systematic regional differences are not obvious, but may include cultural differences in lifestyle, legislation and enforcement (for example a number of countries in the Americas are unable to conduct effective random breath testing due to constitutional rights similar to those of the United States: Job, Lancelot, Gauthier, Silva, Howard, Ledesma, et al., 2015). The leading road safety countries in Europe had also shown strong improvements even before the impacts of the COVID-19 pandemic, with Norway, Sweden and Switzerland all dropping to below 2.2 deaths per 100,000 people in 2019 (ETSC, 2020). These impressive results demonstrate achievements which should be set as

Table 1. Change in crash death rate per 100,000 for HICs, MICs, and LICs (Sources: WHO, 2013, 2015, 2018).

Year	Rate HIC	Rate MIC	Rate LICs
2010	8.7	20.1	18.3
2013	9.3	18.5	24.1
2016	8.3	19.2*	27.5
% Change 2010 to 2016	-4.6%	-4.5%	+ 8.2%

* Not directly provided. Estimated from other percentages provided by WHO.

Table 2. Annual Costs of Crashes as a Percentage of Annual GDP and Estimated Life Years Lost to Disability by World Bank Region (Source: Wambulwa & Job, 2019).

World Bank Region	% of GDP paid in Crash Costs	Estimated Life Years Lost due to Crash Disability per 100,000 people
Africa	9.0	1,149
East Asia & Pacific	6.1	1,017
Europe & Central Asia	4.8	695
Latin America & Caribbean	6.0	878
Middle east & North Africa	5.5	910
South Asia	6.9	863

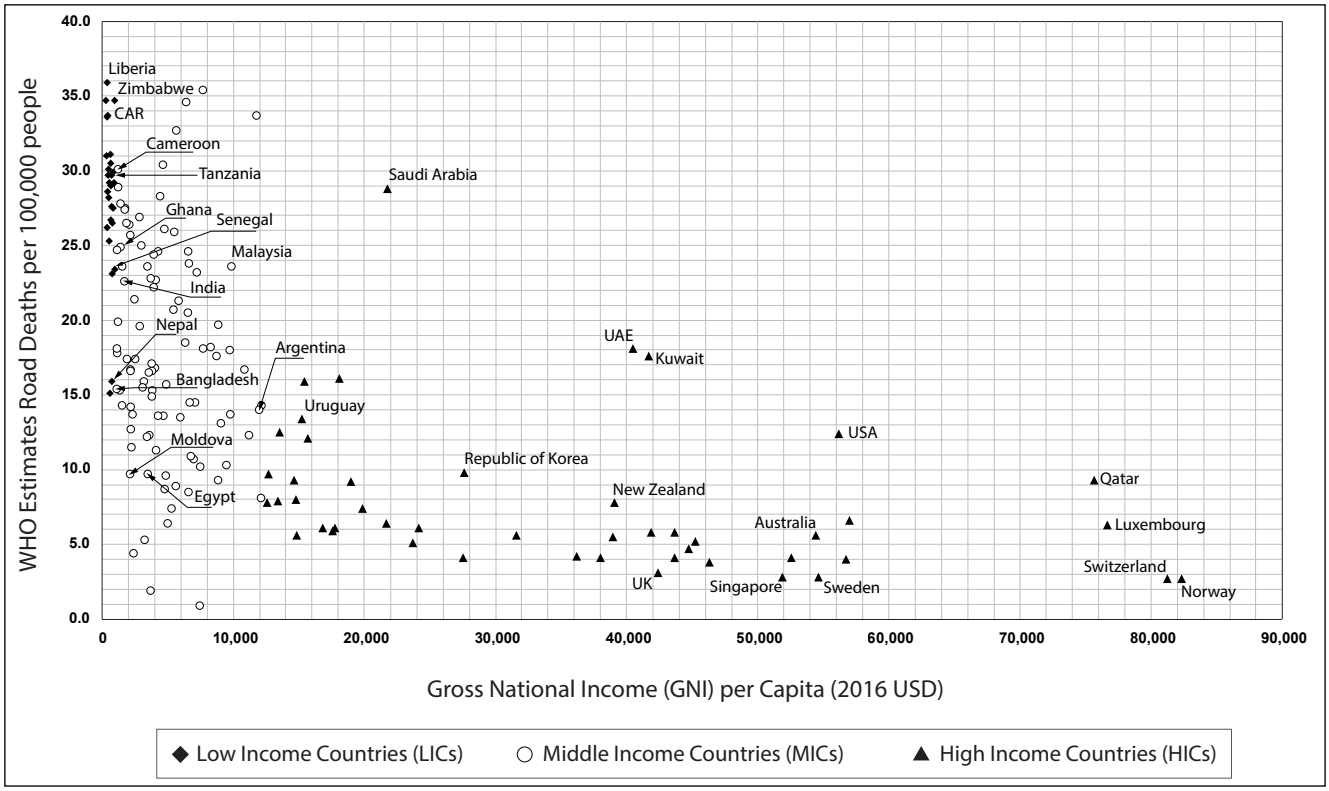

Figure 1. Road death rates per 100,000 people with GNI per Capita of countries in different income regions (Source Heydari, et al., 2019 with data labels added from WHO 2018)

targets for other HICs such as Australia and New Zealand, which now also lag behind Singapore, the regional leader in road safety performance. Nonetheless, Singapore's advantages as largely a city country must be acknowledged.

Demographic and topographic influencers

Many factors contribute significantly to the much greater death (and also serious injury) rates for LMICs. While much of the variation in performance is derived from factors directly related to management of road safety, as briefly considered below, demographics and social geography also play important roles. Five are considered here. The first example is population age which is well recognized to influence consumption and risk (Liddle & Lung, 2010), including risk taking and exposure to road travel which vary with age, resulting in risk of death steadily increasing from birth the around age 18-21 years, then gradually decreasing. Thus, countries with younger populations face greater challenges, and this correlates with country income: 8 of the 10 countries with the lowest median population ages (all with 50% or more of the population below 18 years old) are LICs in Africa (with the other two being fragile states) whereas all 10 countries with the highest median age (with more than half the population aged over 44 years) are HICs (Wikipedia, 2020a).

Second, rural populations are at higher risk of road crash death than urban dwellers (Zwerling, Peek-Asa, Whitten, Choi, Sprince, & Jones, 2005). Based on various countries for which sound crash data are available, rural dwelling people have long suffered 6 or more times the risk of road crash death compared with metropolitan people. For example, in NSW in 2009 metropolitan areas with most of the population suffered 143 deaths, while the rest of the state suffered 310 deaths (NSW Centre for Road Safety, 2010). This trend continues with metropolitan NSW having a rate of 1.8 deaths per 100,000 people versus non-metropolitan NSW with around 6.5 times the death at 11.6 deaths per 100,000 inhabitants (NSW Centre for Road Safety, 2019, with population data from Wikipedia, 2020).

Similarly, consistently over years, Adelaide's population of 70 to 75% of the total for the state of South Australia has around half the serious casualty crashes and only a little over 25% of deaths (e.g., Department of Planning, Transport and Infrastructure, 2014). Finally, in New Zealand, the rest of the country has a crash death rate per 100,000 people which is 60% higher than the rate for the three major cities (Auckland, Wellington, and Christchurch: crash data from Transport New Zealand, 2020; population data from Wikipedia, 2020). These data confirm the broad pattern, though they under-estimate the differential of rural dwelling versus urban because many regional cities are included as non-metropolitan. The increasing preponderance of more severe outcomes in rural areas reflects the high-speed environment, delayed post-crash care, less enforcement pressure, and unforgiving roads for the travel speeds. Rural communities, especially in LMICs, are affected by higher-speed roads including through built up villages or settlements, in which the function of the transit road is in reality residential and commercial. Engineering measures (gateway treatments, speed humps, raised platform

Figure 2. High risk cliff-side roads in western Nepal with and without crash barriers added by GRSF with UK Aid funding (source: Photos by RFS Job)

crossings, etc.) are already widely applied in HICs to ensure a smooth transition from outside built up area high speeds, to lower speeds appropriate for the safety of vulnerable road users. These engineering measures to reduce speeds are much less common in LMICs, though gradually increasing in application (Welle, Sharpin, Adriazola-Steil, Job, Shotten, Bose, et al., 2018). Urban road safety nonetheless remains a critical focus due to deaths (though in lower population rates) and higher proportions of serious injuries.

Third, in addition to population density, topography influences risk. Mountainous roads present more risk than roads on flat terrain, through typically having more unpredictable curves, and presenting high risk in the event of error when driving near cliffs and drop-offs. These roads are more expensive to build, and more costly to make safe with roadside barriers to protect users from falling over cliffs. This risk is more challenging for LICs to manage. This also offers major opportunities for improvement in LMICs. For example, the installation of 7.3 km of barriers on cliff-side roads in western Nepal by GRSF has already saved 270 lives in the first year and will save 3,450 lives over the life of the project (GRSF, 2020; and see Figure 2).

A fourth factor, sometimes seen as an external demographic for road safety, is the road vehicle mix. In direct statistical terms, the safest form of transport is a large bus, and the least safe is a motorcycle (Sustainable Mobility for All, 2017). Motorcycles typically allow for high speed but do not provide the protection of an enclosed vehicle, making motorcycles the most difficult vehicle to manage in road safety including presenting serious challenges when implementing the safe system approach. Thus, different traffic mixes generate different challenges, with LMICs having much higher proportions of motorcycles (which are inexpensive to run) compared with HICs. Consequently, in Europe 11% of crash deaths are motorcyclists compared with 43% in Asia (WHO, 2018). Even this is an under-estimation of the extent of the problem in LMICs because under-reporting of crashes is systematically biased by crash type, with crashes involving vulnerable road users less likely to be reported than other crashes of similar severity (Kira, Sigal, Tove, Jens, & Carlo, 2016; Bauer, Steiner, Kühnelt-Leddhin, Lyons, Turner, Walters, et al., 2017). It is vital to appreciate that the vehicle mix is not simply a demographic 'given' in road safety but rather a feature subject to influence by various policy levers, including provision of safer alternative transport such as Bus Rapid Transit (BRT) systems which are being adopted increasingly in LICs, BRT pricing policies, vehicle registration and insurance cost policies. Less obviously, regulation and enforcement addressing indiscriminate parking of motorcycles can facilitate the shift to safer transport. Motorcycle parking

Figure 3. Motorcycles parked across footpaths in Asia (panel a) and improved parking allowing for a usable footpath (panel b). Source: Photos by RFS Job

Table 3. Levels of Under-reporting of fatalities by country income comparing official data and WHO estimates (Source: WHO 2018)

Country Classification	Government Reported Fatalities, 2016	WHO Estimated Fatalities, 2016	Difference between WHO and Government Reported Fatalities	% Difference between WHO and Government Fatalities
Low-Income	27,143	171,098	143,955	84%
Middle-Income	517,594	1,057,313	539,719	51%
High-Income	84,628	95,255	10,627	11%

left unchecked incentivises motorcycle use though greater convenience at the cost of increased risk for pedestrians forced to walk on the road by parked motorcycles (Job, 2020; and for examples see Figure 3, which also shows an example of better parking management in Asia).

The fifth factor is vehicle fleet growth. Regional difference in vehicle growth also highlight the growing LMIC problem, with HIC dominated regions growing the least (the European Union vehicle fleet increased only 9% from 2005 to 2015, Japan and South Korea by only 7%, whereas Africa grew by 35% and Asia by 141%: Wambulwa & Job, 2019 based on International Organization of Automobile Manufacturers, OICA, data).

Data, Management, and Delivery of Road Safety

The under-reporting of even serious crashes is a major issue for road safety in HICs, but a larger issue for MICs and an even larger challenge for LICs, with official records in LICs estimated to be missing 84% of crash deaths, let alone serious injuries (See Table 3). There are many reasons for this level of under-reporting and thus it is important not to attribute all these to Police. These omissions cause many problems for road safety including under-representing the extent of the problem, reducing the business case and political demand for road safety actions, and misleading both the nature and location of the problem through systematic biases in which crashes are reported relating to the nature of the crash and its location (Bauer et al., 2017; Wambulwa & Job, 2019). Thus, poor data add to the many other challenges for LICs especially in managing road safety: inadequate funding of road safety, under-funded or absent strategies, and the common absence of a road safety managing/lead agency (Wambulwa & Job, 2019).

The delivery of road safety is also made more challenging for MICs and even more so for LICs across a range of factors. Road infrastructure differences are profound, for example with 94% of pedestrian travel on iRAP 1- and 2-star safety roads in LICs versus 55% for HICs (Wambulwa & Job, 2019), though this remains a disappointing percentage even for HICs reflecting a global neglect of pedestrian safety (Job, 2020). LICs and MICs also diverge on fundamental safe system related policies: 11% of LICs have no national speed limit law versus only 3% of MICs. This reflects a common under-estimation of the importance of speed to both crash occurrence and survivability. Only 52% of LICs regulate used vehicle imports, versus 76% of MICs; No LIC has effective periodic vehicle inspection; Only 22% of LICs have a national seat belt law covering front and rear seat passengers, versus a still inadequate 56% for MICs; While national motorcycle helmet laws are more common: 85% of LICs and 97% of MICs (Wambulwa & Job, 2019), more could be done. Enforcement processes are often hampered by readily avoidable penalties systems. Attempts are made to address this by removing direct interactions of road users and police through speed cameras and other automated enforcement. However, a series of background systems such as vehicle registration and identification, driver licensing, and means of contact (address, mobile phone number) to issue penalties, are often inadequate. Perfection is not required but basic processes are needed (see Job, Cliff, Fleiter, Flieger, & Harman, 2020 for a guide on requirements for camera enforcement).

Conclusions

This paper has briefly described some of the core challenges and features of road safety management in LICs and MICs. These point to vital opportunities for improvement. This brief review of road safety policies and performance shows deep challenges for LMICs in road safety. However, the tendency to treat LMICs (developing countries) as generally similar should be resisted with appreciation that LIC on average differ significantly from MIC on road safety outcomes, implementation of many road safety interventions and policies. Large variations also exist within country income categories, with some noteworthy consistencies within regions. It is worthwhile to research the mechanisms by which similar income countries appear to have systematically different road safety performance from one region to another. Within countries road safety will be well served by maintaining a focus on the rural safety problem as well as urban safety.

Stronger global focus on the suffering of MICs and especially LICs, with 93% of deaths in road safety, is vital. Although the UN Sustainable Development Goal (SDG 3.6) of halving road crash deaths may appear to be met through dramatic inadvertent circumstances (stay-at-home orders and greatly reduced road use due to COVID-19) this is likely to be a short-lived benefit of a tragic global pandemic. Thus, the road safety SDG must be continued with a 2030 target setting up another decade of road safety. The international outreach of the Australasian College of Road Safety to Asia is a welcome contribution towards assisting more LMICs in road safety.

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Adopting Recommendations of a Road Safety Management Capacity Review: addressing a tragic decade of road safety in Romania

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Key Findings

- Romania's road fatality rate per capita is the worst in the EU and third worst compared to 35 OECD countries.
- Ineffective leadership and lack of commitment to strong actions to reduce Romania's road fatalities were observed at various levels of government in the first half of the Decade of Action for Road Safety.
- Main causal factors are inadequate financial commitment, poor road safety education and knowledge among practitioners, high speed limits, weak speed enforcement and unforgiving road infrastructure, combined with risky/ aggressive driving behavior.
- From 2016-2020 valuable actions were undertaken, adopting key recommendations of the road safety management capacity review undertaken in 2015/16.
- Well financed structured programs implementing Safe System road infrastructure, a centralised road safety regulator, lower speed limits, and stronger speed enforcement will be needed to further reduce fatalities.

Abstract

This article outlines a capacity review of Romania's national road infrastructure and road safety in general. Romania's road fatality rate per 100,000 population has improved overall from a 2008 high of around 15 to the current 2019 value of 9.6. However, the rate has flat-lined with no real improvement for the last decade, stalling at around 9.7 over the period 2011-2019 and around double the EU rate. Moreover, Romania's total annual number of road deaths has remained at an average of around 1900 fatalities per annum over this period. Romania has been the worst performing country in the European Union (EU) in recent years, and one of the worst performing countries compared to Organisation for Economic Co-operation and Development (OECD) nations in terms of road safety. The review performed in 2016 found inadequate political leadership and commitment to effective actions to reduce road fatalities, fragmented government road safety activities across a number of regulatory entities, speed limits set at levels that exceed internationally accepted survivable limits, weak traffic law enforcement including a lack of speed enforcement cameras resulting in a failure of drivers to comply with speed limits, and a lack of structured programs to implement human error tolerant road infrastructure constructed according to Safe System principles. A series of recommendations from the capacity review were adopted (as described here) since 2016, although much remains to improve road safety in Romania.

Keywords

Romania, Road Safety Review, Safer Road Infrastructure, Safer Speeds, Enforcement, LMIC

Glossary

European Union (EU) - As of 1st January 2020, the European Union is a political and economic union of 27 member states that are located primarily in Europe. Prior to 2020 the UK was a member (28 countries). Romania joined the EU as of 1st January 2007.

General Transport Master Plan (GTMP) - Romania's Ministry of Transport's key strategy documents for road transport ratified in September 2016.

Global Road Safety Facility (GRSF) - A global multi-donor fund hosted by the World Bank. Its mission is to help governments develop road safety management capacity and scale up road safety delivery in low- and middle-income countries (LMICs).

National Company for Roads Infrastructure Administration CNAIR (in Romania, formerly the National Company for National Roads and Motorways-CNADNR)

Lower Middle-Income Country (LMIC) - Definition of a country's economic status based on a per capita gross national income: Low-income economies are $1,025 or less; lower middle-income economies are between $1,026 and $3,995; upper middle-income economies are between $3,996 and $12,375; high-income economies are $12,376 or more.

Organisation for Economic Co-operation and Development (OECD) - A group of 35 member democratic countries that support free-market economies and develop economic and social policy.

Romania (RO) - Acronym used in charts and graphs by EU for identifying Romania.

Romanian Road Authority (ARR) - Romanian government authority responsible for driver and instructor training, licences and road safety.

Road Safety Impact Assessments (RSIA)

Road Safety Inspections (RSI)

Supplementary Road Safety Inspections (SRSI)

World Bank (WB) - International financial institution that provides loans and grants to the governments of poorer countries for the purpose of pursuing capital projects.

Introduction

The European Parliament and Council adopted on the 19th of November 2008 Directive 2008/98/EC regarding road safety management, thus emphasising the increasing importance of road safety in the EU jurisdiction (European Union, 2008). The European Commission (EC) also adopted a target of reducing the number of road deaths on Europe's roads by half over the following 10 years (E C, 2010). The United Nations also, through the resolution adopted on the 2nd of March 2010, recognised the gravity of the road safety problem by declaring the decade 2011-2020 as the "Decade of action in road safety".

The EU Directive 2008/96/EC on Road Infrastructure Safety came into law in Romania in 2008 as set out in Law 265/2008 (Government of Romania, 2008). By inference, Romania was also required to halve their road fatalities. However, this target requirement was not recognised by the Romanian government until it amended the 2008 law via an Emergency Ordinance 22 tabled in June 16th, 2016 (Government of Romania, 2016A). Nonetheless, the amendments were mostly focused on road safety audits and inspections and freeing up Romania's capacity regarding certification of road safety auditors and inspectors. The amendment only spoke about possible fatality reductions of up to 60% via road safety audits. No actual target was set in that amendment of the Law. Similarly, no target was set in Romania's national General Transport Master Plan (GTMP) for transport that was initially proposed in 2006 which was then revised and ratified in September 2016 despite this plan being one of Romania's Ministry of Transport's key strategy documents for road transport.

However, the 'National Road Safety Strategy and Action Plan for the Period 2016 – 2020', an important document that is the first of its kind focusing on road safety, adopted by the Government of Romania via Decision 755/2016, states "*The overall goal of this strategy consists in halving the number of deaths from traffic accidents until 2020, compared to 2010, so that in 2020 there should be recorded no more than 1,188 deaths, compared to 2,377, in 2010*." (Government of Romania, 2016B). Hence, the ambitious target to reduce the number of Romania's road fatalities by half was officially set, in line with the EU Directive and the Decade of Action in Road Safety goal.

It is worth noting that there was a surge in economic activity and subsequent rise in private motorised vehicle ownership in the period 2000-2011, particularly so after Romania joined the EU in 2007. Figure 1 shows the fatality rate per head of population started to rise in 2003 to a peak in 2008. Countermeasures such as stronger law enforcement, improvements to road infrastructure, training of drivers and presumably enhanced legal interventions in terms of culpable driving resulting in court prosecutions, helped reduce fatalities over a period from 2008-2014 (Figure 2). However, whilst Romania's road fatality rate per 100,000 population improved overall from a 2008 high of around 15 to the current 2019 value of 9.6, the rate started to flat-line with no real improvement for the last decade, stalling at an average of 9.7 over the period 2011-2019 as is obvious in Figure 1. Romania's population is almost 20 million for an area similar to the state of Victoria in Australia.

Alarmingly Romania's fatality rate per 100,000 population is almost double the EU rate (5.1 in 2019) and OECD rate (5 in 2017), and more than triple compared to EU road safety best performing countries (rate between 2 and 3 in 2019 for Norway, Sweden, Ireland, UK, Switzerland) (ETSC, 2020, BITRE, 2019). Moreover, Romania's total annual number of road deaths has remained at an average of around 1900 fatalities per annum over this period with a total number of just over 20,000 road fatalities in the past decade as indicated in Figure 2. This has resulted in Romania becoming the worst performing country in the EU (Figure 3) and one of the worst performing in the OECD nations in terms of road safety.

Romania's National Company for Roads Infrastructure Administration, CNAIR (formerly the National Company for National Roads and Motorways (CNADNR), who are responsible for road safety on Romania's national road network and motorways, which constitute around 26% of all of Romania's roads, were particularly concerned about the lives lost under their watch. CNAIR approached the World Bank (WB) office in Bucharest to assist with carrying out a road safety capacity review with a focus on assessing the safety of road infrastructure and how to improve it. Fatality data provided by CNAIR for analysis to the WB road safety expert team tasked with providing technical assistance is summarised in Table 1. The data revealed that around 54% of all road deaths occurred on roads administered by CNAIR and a large proportion of these were pedestrian involved fatalities. An analysis by Romania's Ministry of Interior (Police) for the year 2014 also shows that around 37% of

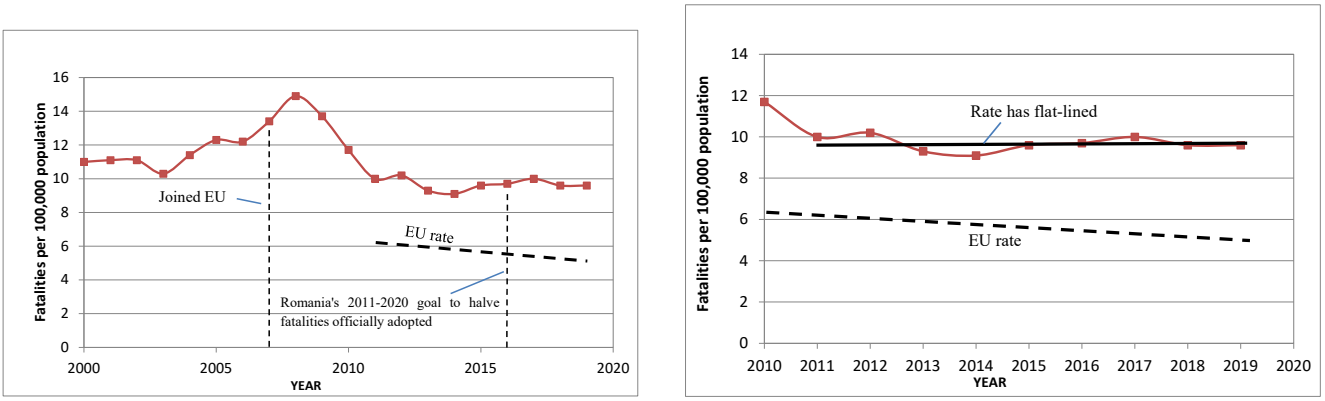


Figure 1. Romania's road fatality rate per annum (source: European Commission)

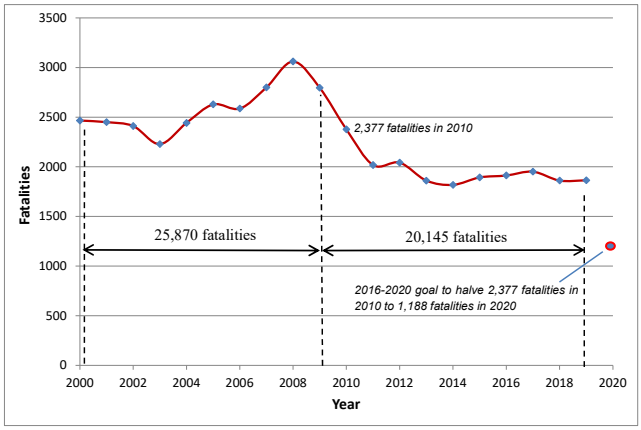
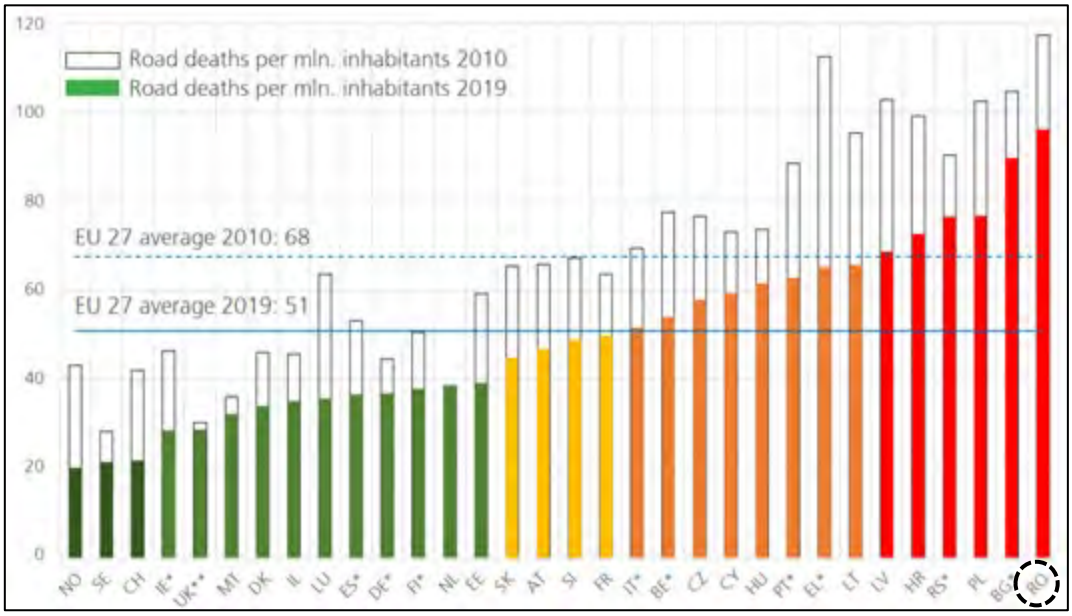


Figure 2. Romania's total road fatalities per annum (source: European Commission)



Austria (AT), Belgium (BE), Bulgaria (BG), Croatia (HR), Czech Republic (CZ), Cyprus (CY), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (EL), Hungary (HU), Ireland (IE), Israel (IL), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Malta (MT), Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), Romania (RO), Serbia (RS), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE), Switzerland (CH), U.K. (GB)

Figure 3. Romania's (circled) road fatality rate (source: ETSC, June 2020)

Table 1. Romania's road fatalities on according to road type 2011-2016 (Source: GRSF, 2017)

Crash year	Other Roads	Motorway	Communal Roads	County Roads	National Roads	Streets	Total
2011	30	16	74	381	1,076	441	2,018
2012	29	17	109	363	1,098	426	2,042
2013	27	24	89	322	1,020	379	1,861
2014	40	21	78	364	949	366	1,818
2015	22	19	113	346	1,017	375	1,892
2016	33	26	97	351	1,000	406	1,913
Total	181	123	560	2,127	6,160	23,93	11,544
Percentage	2%	1%	5%	18%	53%	21%	100%

fatalities are pedestrian involved crashes compared to motor vehicle occupant fatalities (drivers and passengers) and other crash type fatalities (e.g. motorcyclists, cyclists, etc.). Pedestrian fatalities are often considered the 'canary in the coal mine' indicator that speed may be a major causal issue on these roads.

This article presents some of the results from the road safety capacity review and assessment of the safety of road infrastructure on the roads administered by CNAIR (GRSF, 2017), but also the progress following the recommendations provided to CNAIR.

Method

Various technical assistance tasks were conducted by an expert team as part of a broad Road Safety Management Capacity Review based on World Bank review guidelines (Bliss, Breen, Job & Rouse, in press). Of these, two main tasks presented in this paper focused on reviewing why Romania's fatalities were high and why the fatality rate reduction was stalled. These tasks were (i) an assessment of the working relationships between road safety stakeholders within Romania's institutional framework, and (ii) access and analysis of the crash data and identification of the major crash causal factors and crash mechanisms. Analysis of the key road infrastructure problems and challenges that are contributing to fatal road crashes was also carried out. However, for brevity, that analysis will be reported in a later paper. Only a couple of examples relevant to speed will be presented here.

The analysis results presented are based on site visits, desktop research as well as information provided by interviews and structured discussions with CNAIR, the Romanian Road Authority (ARR), and the Road Traffic Directorate of the Romanian Police. ARR is responsible for driver and instructor training, licence register as well as road safety legislation and management of safety assessments such as Road Safety Audits (RSA), Road Safety Impact Assessments (RSIA), Road Safety Inspections (RSI) and Supplementary Road Safety Inspections (SRSI). The Police are responsible for approving infrastructure projects within a safety commission, recording traffic crashes and maintaining the national crash database. These entities were identified by the team as the key road safety stakeholders at the national level, although other government entities were deemed as making a contribution and were required to provide assistance, such as Ministry of Finance for budgeting, Ministry of Education for establishing road safety curricula in schools, Ministry of Development overseeing county roads, and others (Figure 4). Even though CNAIR is the key player in road safety management of national roads and motorways, ARR and the Road Traffic police are also involved and oversee road safety of the entire Romanian road network, beyond national roads and motorways.

Structured interviewees (broadly based on Bliss et al., in press) provided a considerable degree of freedom to express their opinion and expertise. Questions also covered the operational procedure and management processes that interviewees may have been involved in or considered.

De-identified crash data was provided to the WB team by the Road Traffic Directorate of the Romanian Police. The data provided included the number of fatalities, date and time, location, whether the crash was urban or non-urban, road characteristic (straight or curved), existence of signs, street lighting, lane separation, shoulder characteristics, road barriers and their type, overtaking restrictions; conditions and type of road surface (wet or dry), lighting (cloudy, dawn, daylight), weather (dry, rain, snow); main cause of crash (speeding, fatigue, struck pedestrian, etc.), crash mechanisms (rollover, side impact, struck object, etc.). No case files or crash details such as vehicles types were available.

Whilst data analysis was carried out by the WB team, crash causation was determined by the Police. Crash data are collected by the Traffic Police and specific case files and detailed forensic data can only be analysed by them. Interpretation of the crash causation is carried out by the Police and then a summary of the data is provided in a spreadsheet to other institutions.

Data were analysed to identify crash clusters where there was a high casualty count, essentially blackspots. Nine mid-block road crashes and three intersection crashes were

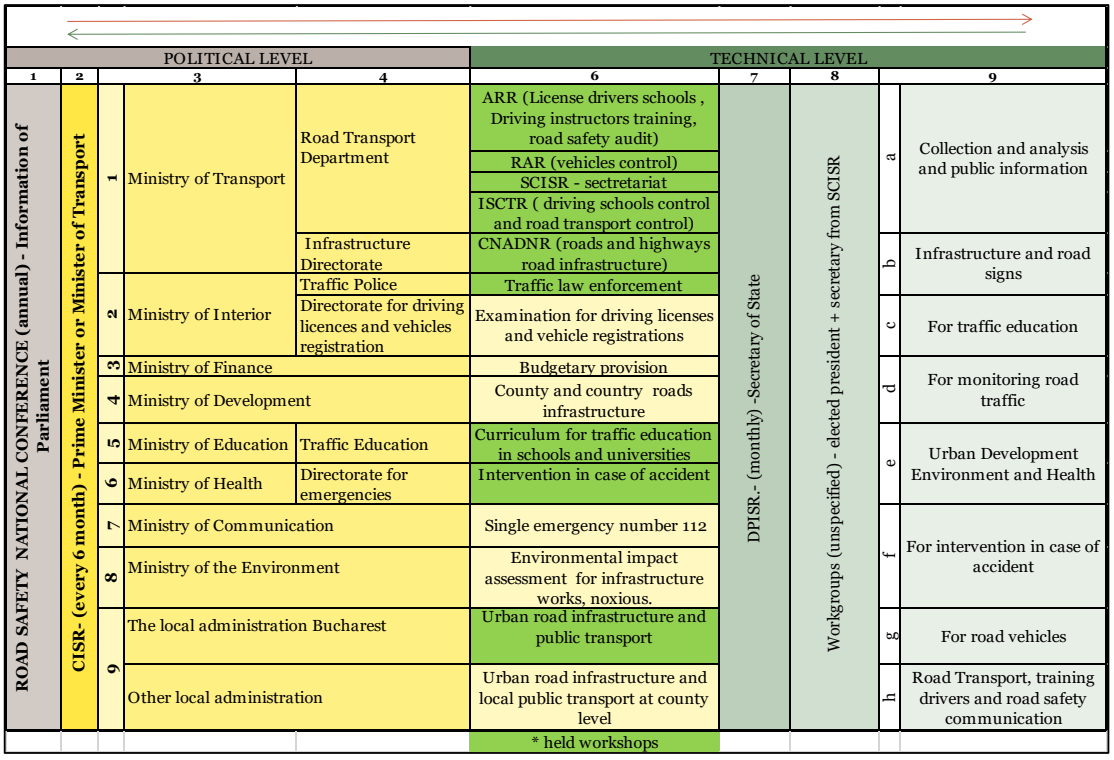


Figure 4. Institutional Framework: Government Ministerial Departments and Institutions and their interrelationship related to road safety and road transport

found using the 2011-2016 crash database provided by the Romanian Traffic Police. Another seven crash cluster locations were also identified from a 2007-2012 black spot analysis carried out by consultants who assisted the Romanian government draft the original GTMP. These were further assessed by the WB team but for the years 2011-2016 to see if the number of casualties had increased or decreased. All of these sites were deemed as black spot sites. All but one of the sites was visited by a member of the WB team and drive through in both directions was recorded using a Go-Pro camera mounted in the vehicle. Google Earth and Google Map Street view was then used to carry out a desktop review of these sites and recommended injury reduction countermeasures were provided. However, as mentioned earlier, the analysis is not the object of this paper and will be reported at a later date.

Conclusions were then drawn from all of these analyses and a series of recommendations were provided to CNAIR. Only brief aspects of the institutional framework review and crash data analysis work are presented below, together with a few examples on how WB recommendations were put into action.

Results and Discussion

Institutional Framework

Figure 4 above shows the current diverse range of Romanian government institutions that address the broad aspects of road safety related activities, namely: the Inter-Ministerial Council for Road Safety (CISR), the Permanent Inter-Ministerial Delegation for Road Safety (DPISR), a Road Safety Directorate within National Company for Roads Infrastructure Administration CNAIR (formerly CNADNR), the Romanian Road Authority (ARR), the Romanian Automotive Register (RAR), the Road Directorate of the Romanian Police (DR), the Directorate for Driving Licensing and Licence Plates (DRPCIV), and the State Inspectorate for Road Transport Control (ISCTR).

The CISR is a governmental consultative body addressing road safety policy aspects at the national level providing an institutional framework for legislation and organisation of road safety. This Council was established in 1995, however, it only became active after 2008 when its activities were formalised and legislated (Government of Romania, 2008). The members of this CISR are divided into three groups: Ministerial level, local authority level and other associations. The first group is represented by the following Ministries: the Ministry of Transport (i), Ministry of Internal Affairs (ii), Ministry of Public Finance (iii), Ministry of Rural Development (iv), Public Administration and European Funds (v), Ministry of Environment (vi), Ministry of Communication and Informational Society (vii), Ministry of Education (viii). The second group consists of the following local authorities: Bucharest local administration (i), Romanian Federation of Local authorities (ii), Romanian association of Cities (iii), Romanian Association of Villages (iv), National Union of Romanian County Councils. The third group is represented by the following associations: Non-Governmental Organisations (i), academia (ii), research institutes (iii), and private companies that are (partially) involved in road safety. The President of CISR is the

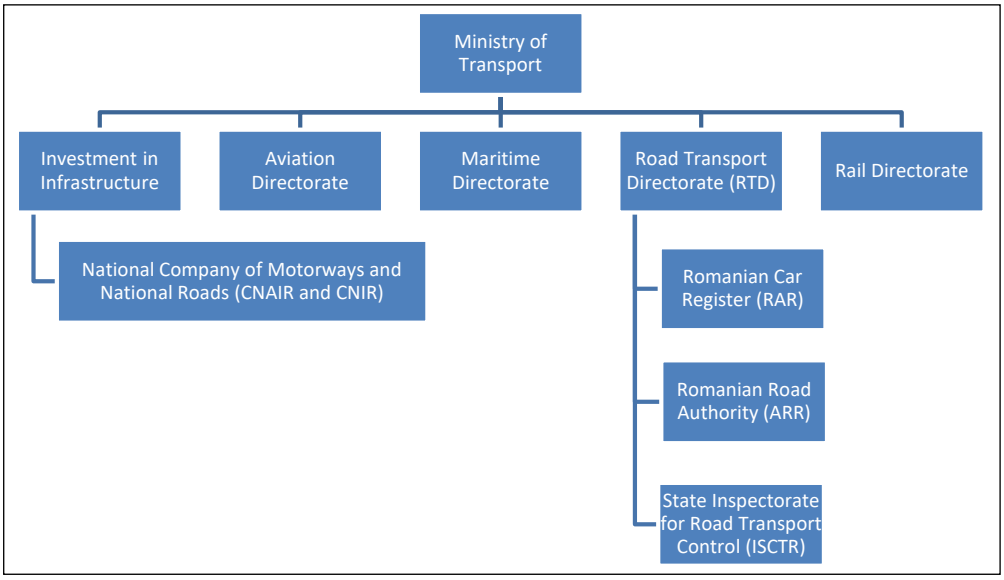


Figure 5. Diagram of government entities/ directorates within the Ministry of Transport

Prime-Minister of Romania, and the Council is chaired by the Minister of Transport. Figure 5 below shows a diagram of government entities/ directorates within the Ministry of Transport.

The DPISR is a working group of road safety experts within CISR. This group was set up to ensure the continuation and implementation of the National Road Safety Strategy (NRSS) (Government of Romania, 2016B). Together with CISR, DPISR is responsible for shaping the priorities of the national action programmes regarding road safety and for raising awareness regarding road safety in Romania in general.

The CISR, as a lead national agency, does in principle exist with the aim and responsibility to direct the national road safety effort. Moreover, the lead agency's role is defined in legislation. The members of the CISR and the associated DPISR generally appeared to be the right organizations to lead road safety and most of the involved institutions (CNAIR, ARR, and Traffic Police) appear active and motivated at a professional level. However, at a political level, CSIR's responsibility and interest appeared unclear. The review found that:

- At the Ministerial political level regular meetings were supposed to occur. However, these were not taking place when the WB team were carrying out the capacity review.
- DPISR did not hold any meetings from around 2012 to 2014 and then from July 2015, monthly meeting activities were relaunched. It appeared some road safety countermeasure activities were agreed to and minutes prepared but no follow up as to whether the proposed road safety countermeasure activities had been carried out.
- No dedicated funding and budget for the CISR and the associated DPISR was allocated. Each institution (CNAIR, ARR and Police) had to find resources from its own budget, which was a considerable disincentive. No active finance experts or people from treasury attended CISR even though significant sums of money were collected from traffic infringements.
- Some politicians feared a backlash from voters regarding any road safety measures they would recommend, such as increasing for example enforcement, introducing speed cameras (covert, fixed point and point-to-point) and reducing speed limits.
- Interventions seem to be coordinated horizontally across most main key stakeholders but vertically only to some extent between national, county and city agencies.

What was clear from the interviews and the institutional framework review was that the road safety efforts appeared to be decentralised with a number of disjointed government road safety activities across a number of regulatory entities. For example, CNAIR was responsible for road safety on national roads and motorways whereas ARR were responsible for road safety legislation for all Romanian road network. Moreover, CNAIR had to rely on ARR for road safety audits, who were the only institutional body who could carry out road safety audits, causing an inherent bureaucratic and financial impediment for improving the safety of national roads and motorways. Up until the Emergency Ordinance 22 was passed in June 16th, 2016 (Government of Romania, 2016A), there was a very limited number of certified road safety auditors and inspectors. Under the initial provisions of Law 265/2008, it was not possible to train new road safety auditors due to this regulation being too restrictive regarding newly certified auditors being used for any new projects. Also, the fees established by the norms of the Law 265/2008 (Minister of Transport and Infrastructure Order no. 480/2011) were extremely high compared to other good practice countries, e.g. the cost for a road safety audit reached 50,000 euro per km. This in turn led to a deficiency in road safety audit operations, which in turn prevented the construction and

modernisation of road infrastructure. This also led to the forfeiting of any available European funds that could be allocated for such projects. The scope of the law exceeded the provisions as set out in the respective EU Directive.

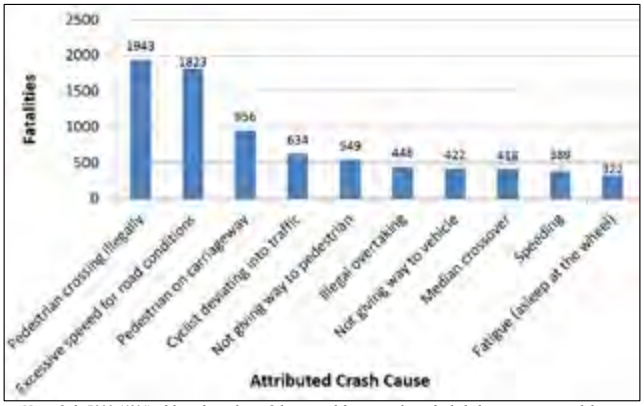
These early institutional arrangements and obvious lack of political interest to introduce known evidence-based injury prevention countermeasures, such as increased speed and other enforcement, all pointed to being one of the main causal factors for such a poor road safety performance in Romania.

The National Road Safety Strategy and Action Plan 2016-2020 was officially adopted in 2016 by the Government through Decision 755/2016, and together with Emergency Ordinance 22, Law 265/2008 was updated thus allowing various agencies like CNAIR, ARR and Traffic Police to enhance their inter-institutional coordination and to develop stronger road safety activities essentially from 2017 to now and of course into the future.

Crash Data Analysis

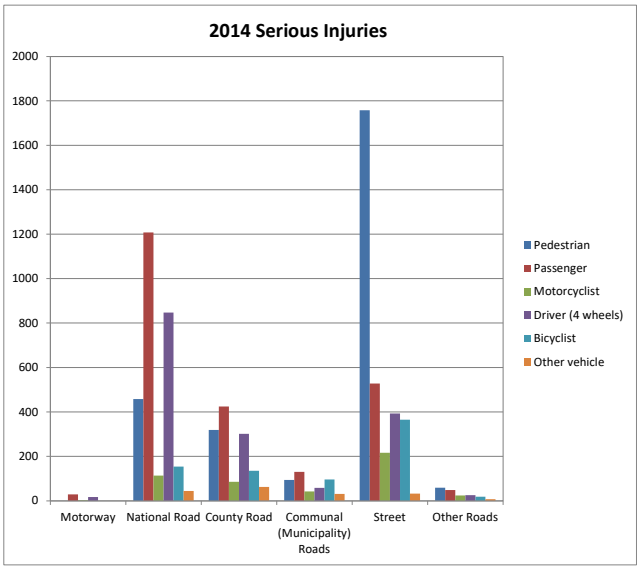
The de-identified data provided to the WB team was analysed to determine the scale of the problem as well as the underlying causal factors. Figure 6 shows that the majority of fatalities were attributed by Police to 'inappropriate' behaviour of pedestrians and excessive speed for the road conditions. Further analysis of 2014 data carried out and shown in Figure 7 identifies that the majority of fatalities are occurring on national roads that come under CNAIR's purview. Figure 8 presents the time of day when the pedestrian fatality occurred. Dusk and evening fatalities (5 to 9 pm) are approximately double daytime fatalities. The three graphs (Figure 6 to Figure 8) inferred that speed, including inappropriate speed limits and enforcement, pedestrian visibility and road infrastructure on national roads were major issues that required addressing in terms any road safety strategies and policies.

There was concern by the WB team that the data were not being analysed with sufficient detail and clarity by



Note: Only 7902 (69%) of data shown here. Other causal factors such as alcohol, distraction, etc. with lower numbers attributed by Police are not presented

Figure 6. Road fatalities in Romania (2011-2016) (n=11,544 analysed)



Road Lengths - Motorways 635 km, National Roads 15629 km, County Roads 36010 km, Municipal Roads + Streets 27789 km

Figure 7. 2014 Fatalities segregated by crash type and road type (n=1,818 fatalities)

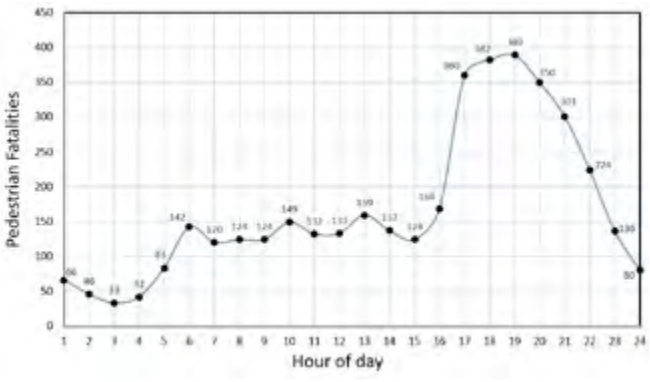


Figure 8. Pedestrian fatalities according to time of day (2011-2016) (n=4,084)

the Police investigators to establish the true nature of the crash in terms of 'system' failure. Usually, when Police alone investigate a casualty crash there is a natural desire to attribute blame to a particular road user involved in the crash. It was felt that this may be impeding progress in terms of reducing road fatalities. Blaming the victim has a long history, and continues to provide considerable hindrance to advancing injury prevention activities and helps to obfuscate the actual causes of death and injury. A crash resulting in injury may represent a possible failure or inadequacy in some component of the vehicle-road system to protect road users from severe injury. Crashes provide feedback on system performance and should be viewed and analysed with a neutral perspective (Rechnitzer and Grzebieta, 1999, Grzebieta and Rechnitzer, 2001).

The team that analyses the data should be a mix of 'neutral' professionals who cover off statistical and human factors expertise, epidemiology, road crash investigations and reconstructions, road safety audit, road safety inspections,

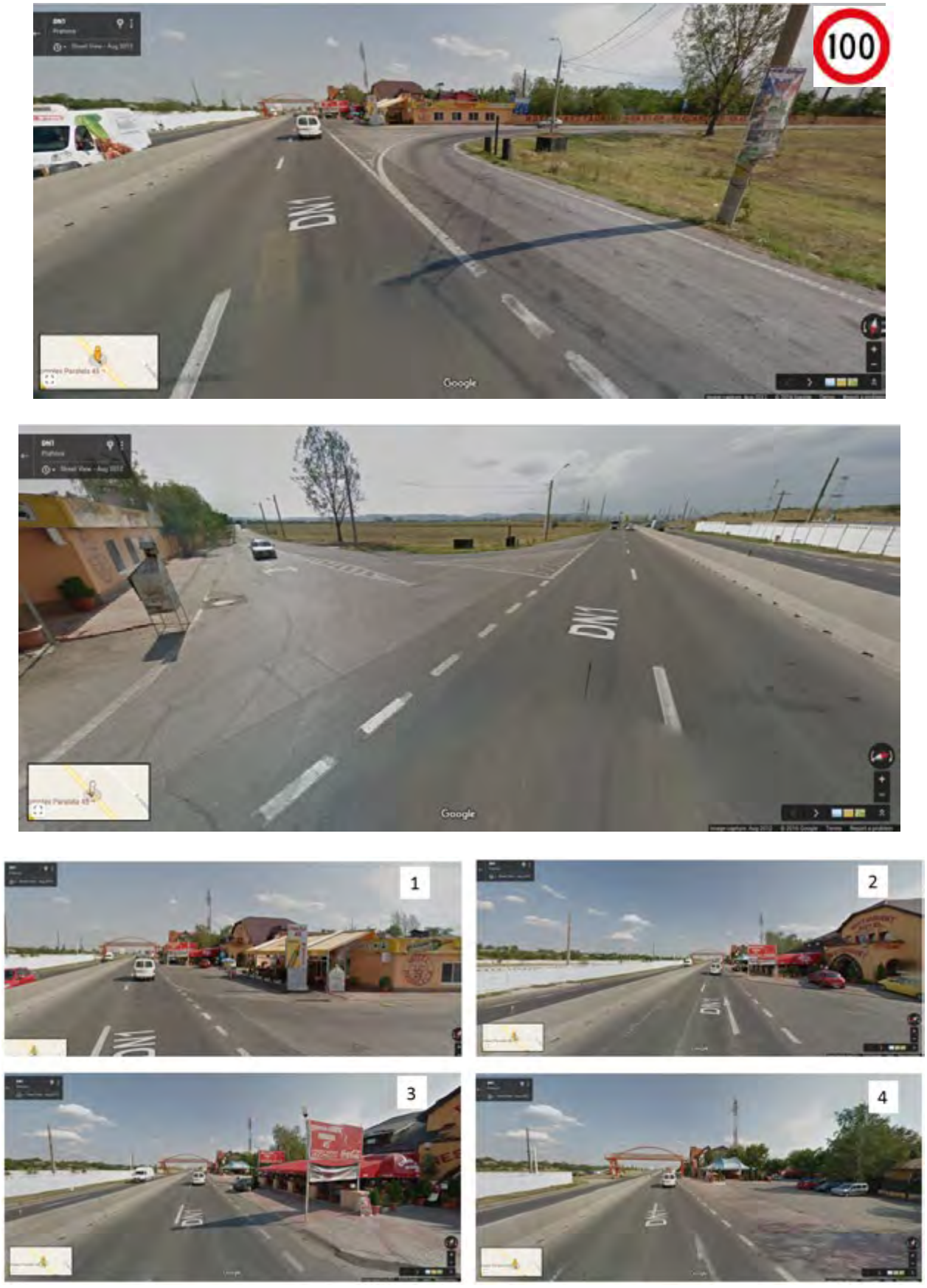


Figure 9. National Road 1, on approach to a group of shops, restaurant and eating places and petrol station on the right. Speed limit set at 100 km/h.

Figure 10. Downtown Bucharest in one of the main shopping precincts where there are large numbers of pedestrian shopping at local department stores. The speed limit is set at 60 km/h, which is essentially not survivable if struck at this speed.

traffic and road engineering related to road safety and effective enforcement strategies that assist drivers and pedestrians from a safe system perspective. Moreover, this data should be accessible for other research institutes who can assist with identifying the link between causal factors and proposed countermeasures.

The WB team found in 2017 that crash data for a specific location is only requested by CNAIR and ARR on an ad-hoc basis in order to analyse a safety issue that may be associated with a particular segment of national road. The exchange of the crash data between the CNAIR, ARR and the Police was not yet regulated or harmonised when the capacity review was carried out. Discussions with CNAIR, ARR and the Police however identified that all three organisations consider it important that crash data is made readily available. In other words, ideally crash data should be publicly available and yearly updated so that CNAIR, ARR and road safety research organisations can carry out much need analysis of the data, which in turn would benefit road safety in Romania.

Two illustrative examples where it was obvious the speed limit was grossly excessive and yet the road user was blamed if struck by a vehicle are shown in Figures 9 and 10. This was in contrast to the local road authority perceiving the high crash risk and the taking positive action to prevent further casualties.

In the first example, Figure 9 shows a four-lane road (National Road 1 - DN1) with a median concrete barrier separating two lanes where vehicles travel in opposite directions. The speed limit is set at 100 km/h. Vehicles in the right two lanes travel past a T intersection and then a series of eating places, restaurants, shops, a petrol station and a rest stop with lavatories, grouped over a length of around one kilometer. Vehicles were slowing down to a slow speed and turning into restaurants, shops, petrol station, car park etc. Vehicle occupants, including children, exit the car and wander around the car park while at the same time traffic can legally travel past the car park at 100 km/h. Vehicles were also reversing out of car parks by the side of the road at the restaurants (see frame 3).

There have been 6 fatalities and 7 serious injuries at this site. Four of the fatalities were pedestrians and two were car occupants. In four of the incidents involving pedestrians, Police attributed blame to the pedestrians as having illegally crossed the road. In regards to the vehicle occupants, it was stated that vehicle driver approaching the intersection along the stem of the T intersection did not give way to vehicles approaching at 100 km/h along the straight section.

According to the local engineer responsible for the safety of this road when questioned in a workshop, the series of commercial entities were all built without a government-building permit. Hence, the inconsistencies between the road environment and the speed limit.

To blame the pedestrian that they made an illegal crossing in a pedestrian active area where there are no signs or speed limits nor warnings that are appropriate for the conditions, is the antithesis of what the Safe System principles are all about, i.e. humans make errors so the system must be designed to compensate for those errors. Obviously, the speed is much too high, particularly when considering perception reaction times of a driver travelling at 100 km/h. Vehicles waiting at the stem of the T-intersection will have difficulty in perceiving vehicles approaching that are travelling at 100 km/h. Moreover, because of inadequate speed enforcement, vehicles were often observed to be travelling at 110 to 120 km/h. This would further exacerbate such a human inability to perceive a vehicle approaching at a high speed and being able to judge if it is possible to pull out in time with sufficient lead-time to accelerate to a safe speed and not be struck either in the side or rear.

Stating that a pedestrian crossed illegally or that a vehicle did not give way at this site, i.e. blaming the victims is unrealistic, if not negligent in such high-speed conditions where there are a lot of pedestrians in the area. It is also symptomatic of the possible inaccurate assessments of the causal factors that have been coded into the crash database. The Traffic Police should consider all contributory factors when a fatality happens, and if needed, reach out to the road authority, which should ultimately be held responsible for allowing this unacceptable situation to continue, i.e. where

human factor demands for both the vehicle driver and the victims are well beyond their human capabilities resulting in death and serious injury.

A second example demonstrating the excessive speed limit set by local authorities in a major downtown shopping area where the high-risk pedestrians are being exposed to, is shown in Figure 10. The speed limit is set at 60 km/h. However, again because of inadequate speed enforcement and lack of political interest to curb speeding drivers, vehicles were regularly observed to be travelling at 70 to 75 km/h during their green phasing at the intersection. Hussain et al (2019) showed that the risk of a fatality reaches 5% at an estimated impact speed of 30 km/h, 10% at 37 km/h, 50% at 59 km/h, 75% at 69 km/h and 90% at 80 km/h.

Recent Progress

Romanian authorities CNAIR, ARR and Traffic Police have made considerable efforts to adopt key recommendations from the WB Road Safety Management Capacity Review report (GRSF, 2017), and to implement the policies outlined in the National Road Safety Strategy 2016-2020. The modification of Law 265/2008 in 2016 represented the basis for the activities presented below, despite a set back from the Romanian Parliament, who amended Emergency Ordinance

Figure 11. Romanian National Road 2 (DN2) pilot road upgrade program launched in 2019

Figure 12. Romanian National Road 7 (DN7) roller barrier pilot launched in October 2019

no. 22 and removing county roads and urban roads from the list of mandatory roads to undergo RSAs and RSIAs (Government of Romania, 2017).

Nonetheless, an important process that was proposed in the updated law and is currently in use is the Supplementary Road Safety Inspection (SRSI), which is performed by ARR certified road safety auditors, upon notification from Traffic Police or to verify whether RSA recommendations were put in place. Also, failure of the road administrator/investor to request ARR to perform an RSA or RSIA on a new transport project is subject to a fine of 50,000 lei to 100,000 lei (~US$11,600 – 23,200).

Notable progress over the past few years also includes the establishment of a national 3-week Road Safety Auditor training course based on best practice road safety knowledge, led by ARR in partnership with Technical University of Civil Engineering Bucharest (TUCEB). The first course started in November 2016, and it was under a train-the-trainer format with international experts from Germany and Serbia working together with experts from TUCEB to both prepare materials and also undertake RSAs and RSIs. Traffic Police, CNAIR, experts from other universities and from the private sector were invited to attend the course and to be involved in future training. 156 Road Safety Auditors have been accredited nation-wide so far since 2016. This has included four training courses delivered, as well three refresher courses for currently certified auditors. Feedback received from participants, most of whom are seasoned transport engineers, was that they perceive the road now differently, i.e. with a 'road safety' context, post course.

A Manual for Road Safety Auditors in Romania was also released in June 2019, which sets out best practice road safety engineering and is used as the main course material for the RSA courses. The main goal of this manual was *"to change mindsets and show Romanian road safety professionals that safer road environments are possible, sometimes even with very low costs"* (Burlacu F.A. et al, 2019). In addition, CNAIR and TUCEB recently signed in June 2020 a collaborative agreement on various themes such as research and scholarships for students related to road infrastructure that includes road safety.

Post the start of the 2016 RSA courses, RSIs have been carried out on 2,000km of national roads to mid-2020 together with 460 SRSI of fatal crash locations and 350 RSAs of different roads types. The main upgrades that CNAIR have been requested to carry out to enhance safety on these audited roads in 2019 were (based on October 2019 data) related to: traffic signs (40%); road markings (17%); crash barrier (22%); visibility issues (7%); damaged shoulders (5%); potholes (3%). In addition, in 2019 based on SRSIs that were carried out following 420 fatalities on national roads, 94 SRSI reports were prepared with the result that CNAIR must urgently put into place 328 mandatory road safety measures with a further 229 road safety upgrade recommendations when practicable.

With steadily improving collaboration between CNAIR, ARR and Traffic Police, and after considering recommendations provided from RSIs/SRSIs reports and from the 2017 WB capacity review report (GRSF, 2017), CNAIR launched several road safety pilot infrastructure upgrade programs on high risk sectors of their national roads. One of these pilot upgrades is on National Road 2 (also called European road 85 – E85). This road is one of three highest fatality risk roads in the country, and the only link between two important regions of the country, Muntenia and Moldova. The road width is 12.00 meters: 3.50 meters lane width in each direction and 2.50 meters shoulders/emergency lane. A pilot section of the road was upgraded into 2+1 alternative lanes, as shown in Figure 11, following positive fatality reduction experience from other neighboring countries who implemented such upgrades.

Another innovative road safety pilot program recently initiated by CNAIR in October 2019 was the installation of roller barriers on sections of National Road 7 (DN7) based on previous crash history, as shown in Figure 12. These

barriers are considered a "softer" (more forgiving) type of barrier. These novel barriers have already been hit with no apparent major damage, suggesting that they have already saved lives.

Conclusions

Despite recent progress through legislative improvements, better knowledge sharing and innovative road infrastructure pilot programs, Romania has yet to achieve the high reductions in the number of people killed on roads to which it committed in the past years. The life-saving value of the improvements made will only be taking effect from late 2019 and so is not visible in annual data as yet. Wider application of these programs is warranted. The main factors causing Romania to remain the worst performing EU country are, most importantly: inadequate political leadership and lack of high-level commitment to reduce road fatalities; decentralised disjointed government road safety activities across a number of regulatory entities; speed limits set at levels that exceed internationally accepted survivability crash limits for a road infrastructure system that is unforgiving to human error; weak enforcement of traffic laws including a lack of speed enforcement cameras resulting in a failure of drivers to comply with speed limits; and a lack of structured programs to implement human error tolerant road infrastructure constructed according to Safe System principles.

CNAIR, ARR and the Traffic Police should continue to collaborate closely with each other and also work with the Inter-Ministerial Council for Road Safety (CISR) along with other road safety stakeholders.

Improved access provided to detailed forensic crash investigation data to the road authorities from ARR was noticed as a good progress, but this should be expanded further on to CNAIR, as well as to university and research centers where researchers who comply with ethics approval requirements can research the data in detail similar to what occurs in most road safety best practice countries.

It is obvious that Romanian authorities need to urgently increase speed enforcement, review all speed limits on the national and local road network, and pay particular attention to pedestrian safety especially over the evening period. Setting speed limits to survivable levels and increasing speed enforcement through an extensive safety camera program, where fines accumulated from the enforcement are hypothecated specifically to road safety improvements, is the most-effective means by which fatalities and serious injuries can be reduced significantly at a rapid rate. One hopes that this will happen sooner rather than later to avoid another decade where 20,000 road users might die as a result of inaction.

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Smart Cushion Replacement Parts Costs

- 3 main types of components were replaced over the 59 resets
- Shear Pins (2 x $2 = $4) required for every reset
- Delineator Panel ($190) required for 21 resets
- Sled Panel ($1416) required for 4 resets
- The **total cost** of replacement parts over the **59 resets was $9,994**
- The **average cost** for each reset was **$169**

Durability and Robustness

- 31 different Smart Cushion units required 1 or more resets
- 8 Smart Cushions were reset twice
- 2 Smart Cushions were reset 4 times
- 1 Smart Cushion was reset 5 times
- **1 Smart Cushion was reset 11 times**
- Average Reset Time **55 Minutes** (1 person crew)
- **All Smart Cushions were reset fit for service after an impact**

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