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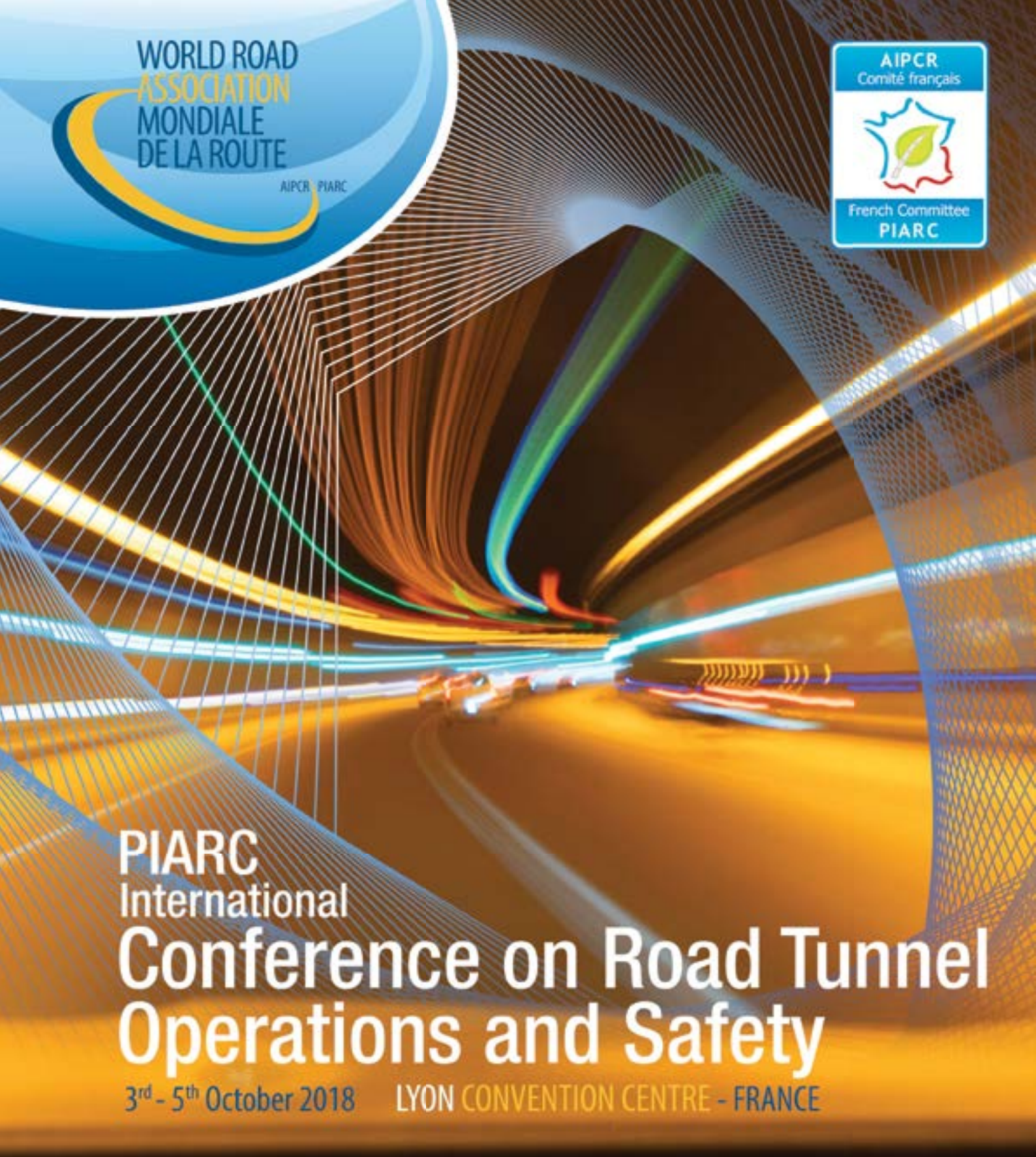
FEATURES

Road Safety

WORLD ROAD ASSOCIATION
MONDIALE DE LA ROUTE
AIPCR PIARC

English Version



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CONTENTS

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GDAŃSK
Poland 2018

XVth International Winter Road Congress

" Providing Safe and Sustainable Winter Road Service "

Gdańsk (Poland), 20-23 February 2018

Merci aux participants au Congrès de Gdańsk

Thanks to the participants in the Gdańsk Congress

Gracias a los participantes en el Congreso en Gdansk

Dziękujemy uczestnikom Kongresu w Gdańsku

WORLD ROAD ASSOCIATION
MONDIALE DE LA ROUTE
AIPCR / PIARC

EDiTORIAL

Patrick Malléjacq
Secretary General of the World Road Association

We have just completed an intense and productive 15th International Winter Road Congress gathering in Gdansk. In cooperation with Poland's Highway and Motorway Directorate (GDDKiA) and Gdansk's Amberexpo Exhibition Center, we accommodated 1,000 attendees representing 42 nations, heard from 4 Transport Ministers and Cabinet Secretaries, showcased 38 technical sessions, 52 exhibitors, and let's not overlook the 22 international snowplow contestants.

This is not the place for an *«off the cuff»* debriefing, suffice it to say we'll be showcasing this Congress in appropriate detail in the June 2018 issue of Routes/Roads (no. 377). But, without any further delay, I'd like here to warmly thank the Polish event organizers and members of our Winter Service Technical Committee for their tireless commitment, resulting in a congress run under optimal conditions, leaving us all with outstanding memories. On the heels of this success, we'll be anxiously awaiting the 16th such event in 2022 in Calgary (Canada).

> *"The articles featured, for the most part from international seminars hosted by Technical Committees C.1 and C.2 reflect the wide geographic and technical diversity of subjects studied by the Association in this field."*

Our magazine's current issue will instead focus on road safety, which to some extent goes hand in hand with winter service and receives special attention in countries prone to heavy snowfall. This topic constitutes a strategic orientation of the World Road Association and, beyond our internal concerns, a major preoccupation for international bodies, beginning at the United Nations, with which we've enjoyed close cooperation when addressing the issue. Road safety will also lie at the heart of OECD's next International Transport Forum, to take place in May 2018 in Leipzig (Germany), whose program this year targets transportation safety and security. The World Road Association will be sending a large delegation and naturally our coverage will be extensive.

The articles featured under this heading stem, for the most part, from international seminars hosted by Technical Committees C.1 *National Road Safety Policies and Programs* and C.2 *Design and Operations of Safer Road Infrastructure*. They reflect the wide geographic and technical diversity of subjects studied by the Association in this field. I'd like to praise the coordination efforts of Laurent Carnis (France), French-speaking Secretary of Committee C.1 *National Road Safety Policies and Programs*, in compiling all these contributions, assisted by Chairmen Roberto Arditi (Italy, C.1) and Shaw Voon Wong (Malaysia, C.2). As demonstrated by this issue's unconventional choice of *«Young Professional»* (p. 22), I'm also acknowledging the artistic initiatives undertaken in the aim of educating children about road safety considerations as early in their lives as possible.

This editorial space offers me the opportunity to remind readers of the importance of the online Road Safety Manual published by the Association ***(https://roadsafety.piarc.org)***. Disseminated in November 2015 on the eve of the Seoul World Road Congress, this tool has become a reference for road and road safety practitioners. Our relevant committees ensure its regular updates, and the English and Spanish versions, highly anticipated for quite some time, are now being finalized. Enjoy your consultation of this manual and, in the meantime, enjoy this issue.#

Update on the World Road Association's actions

IRAN: GREAT SUCCESS FOR THE INTERNATIONAL SEMINAR ON CURRENT POLICIES TO ENHANCE TRAFFIC SAFETY

Tehran (Iran), 23-24 November 2017

On 23rd and 24th November 2017, Technical Committee C.1 *National Road Safety Policies and Programs* of the World Road Association held its fourth meeting in Tehran, Iran. Hosted by the Iranian Road Maintenance and Transport Organization RMTO, the committee members spent two intensive days, dynamically working on progress and development of the Association's Road Safety Manual and a new technical report on national road policies. The meeting was followed by an International Seminar on Policies and Programs for Road Safety, honoured by the attendance of Iran's Minister of Roads and Urban Development, Dr. Abass Akhoondi, who welcomed 200 participants in Tehran.

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THE WORLD ROAD ASSOCIATION'S NETWORK OF EXPERTS ON TRACK FOR ABU DHABI 2019!

Rome (Italy), 4-6 December 2017

The World Road Association's 22 Technical Committees and Task Forces held their mid-term meetings from 4th to 6th December in Rome (Italy). The work of more than 1,200 international experts was reviewed during the course of these working days with a view to publishing it as reports, as well as presenting it and discussing it at the next World Road Congress scheduled to be held in Abu Dhabi (United Arab Emirates), from 6th to 10th October 2019.

***

THE WORLD ROAD ASSOCIATION AT THE 97TH ANNUAL MEETING OF THE TRANSPORTATION RESEARCH BOARD (TRB)

Washington D.C. (USA), 7-11 January 2018

With more than 13,000 delegates and a wide range of contributors including practitioners, researchers, decision-makers and experts, this event included a workshop on road safety in which Patrick Malléjacq, the World Road Association's Secretary-General, took part.

All news available at:
https://www.piarc.org/en/All-News/

AUTOMATED VEHICLES: THE WORLD ROAD ASSOCIATION IS GEARING UP!

Kittilä (Finland), 16 January 2018

Road safety, infrastructure design, operating networks, road equipment... and even the organisational structure of administrations: automated vehicles are bringing profound changes to the road sector. A number of decisive initiatives have already been implemented by the World Road Association.

Claude Van Rooten, the World Road Association's president, was at the 2018 Aurora Summit (Finland) on 16 January where he provided an overview of how various members of the World Road Association viewed automated vehicles.

***

SURF 2018: 8TH SYMPOSIUM ON PAVEMENT SURFACE CHARACTERISTICS

Brisbane (Australia), 2 – 4 May 2018

The good management of road pavements is one of the key priority areas for road managers all around the world and this is why the Association dedicates a Technical Committee D.2 *Pavements* to this important topic. Under the leadership of Mr Seung-Hwan HAN (South Korea), this Committee currently addresses three issues, which are:

1. Sustainable paving solutions and sustainable pavement materials,
2. Low cost pavements systems,
3. Non-destructive pavement monitoring and testing techniques.

What's more, in line with the Association's mission to share and disseminate knowledge, the Australian Road Research Board (ARRB) and the Association's Technical Committee D.2 on *Pavements* will jointly organise the 8th Symposium on Pavement Surface Characteristics, *SURF 2018*.

This conference will include an exhibition, workshops, panel discussions as well as technical sessions, established after a successful refereed international call for papers.

More than 150 experts are expected, including infrastructure owners and managers, road surfacing researchers, academics, industry professionals. The discussions will address recent developments in pavement surface characteristics, methods to improve the quality of road infrastructure, effective management of road infrastructure assets in accordance with user expectations and managers' requests, and will be structured around five key themes:

1. Smart surfaces,
2. Vehicle-road interaction,
3. Data collection with a purpose,
4. Safer road performance,
5. Sustainable and recyclable wearing courses with a focused consideration of Vehicle to Road Connectivity.

The conference will take place from 2 to 4 May 2018, at the Brisbane Convention and Exhibition Centre, in the heart of Queensland's capital city. It will be part of a prestigious series of events, as it will follow the 28th International ARRB Conference, with a focus on *Next Generation Connectivity*, and the Council meeting of the Road Engineering Association of Asia and Australasia (REAAA).

www.surf2018.com.au

Germany

Word Road Association's Technical Visit at BASt

Kirsten Graf-Landmann, Kirsten Graf-Landmann, Technical Advisor at the General Secretariat of the World Road Association

Illustrations © Author unless otherwise stated

On 27th October 2017, the World Road Association (PIARC) visited the Federal Highway Research Institute BASt *(Bundesanstalt für Straßenwesen)* in Germany. In the framework of the World Road Association's annual Council Meeting which had taken place beforehand at the Federal Ministry of Transport and Digital Infrastructure in Bonn, the technical visit of BASt in Bergisch Gladbach and of the new test facility *"duraBASt"* represented the final event for 100 international participants. The *"Demonstration, Investigation and Reference Area"* – duraBASt for short – had just been inaugurated in October 2017.

Illustration 1 – DuraBast infrastructure © BASt

Being able to build and operate a safe, reliable, low-emission and sustainable road infrastructure is one of BASt's objectives. The test facility duraBASt, located on the motorway junction A3/A4 east of Cologne, contributes to achieve this objective.

In the framework of their technical visit, PIARC participants were welcomed by BASt representatives, all of them experts on research and development within department S/GS *"Highway Construction Technology"*.

A general introduction was given by Ursula Blume about the entire site which covers an area of around 25,000 square metres and a total length of more than one kilometre. With different bridge structures, a tunnel-like situation beneath a bridge, noise barriers and drainage installations as well as open stretches of road, the site represents an extensive miniature of today's road traffic infrastructure and the direct road environment.

During guided visits on the test area, PIARC visitors had the opportunity to learn more about duraBASt.

Illustration 2 - Ursula Blume with Patrick Malléjacq

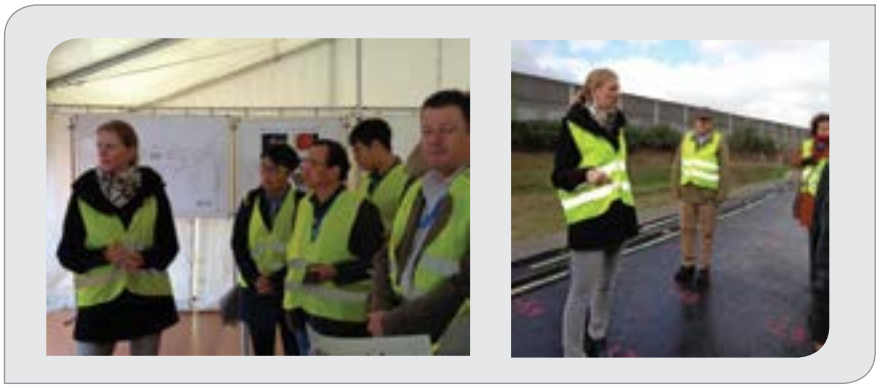


Illustration 3 - Tanja Altemeier with the visitors of the World Road Association explaining reference sections

REFERENCE SECTIONS

Various reference areas with pre-defined surface properties (evenness, skid resistance, surface damage, texture, noise emissions and rolling resistance) were presented by Tanja Altemeier and Christian Gottaut. Here, measuring systems and measurement vehicles can be tested and approved. The reference sections are also used to further develop measuring systems for monitoring the condition of road surfaces on federal trunk roads.

Illustration 4 - Christian Gottaut with the visitors of the World Road Association explaining MEFA

MEFA - MULTI-FUNCTIONAL DETECTION SYSTEM FOR ROAD SURFACE ANALYSIS

The MEFA measurement system is a combined evenness measurement vehicle that simultaneously measures the longitudinal and transverse evenness on roads. Furthermore, the vehicle has the capability to record road surface images to assess surface damage. The monitoring of longitudinal evenness is made by five laser probes which operate in accordance with the HRM principle with two different measurement base lengths. Transverse evenness is monitored by a laser scanner. As Christian Gottaut pointed out, the recording of surface images is made by two-line scan cameras installed at the rear of the vehicle.

SEDA - TESTING OF MULTIFUNCTIONAL ROAD-BUILDING MATERIALS AND COMPOSITES

Explanations about the SEDA research project which is designed to look into the potential of pavements as a source of energy were given by Stefan Höller. The focus and innovation of the project centre both on the potential of roads to convert the thermal energy produced by solar radiation and stored in the road in the form of electric energy, and on the increased durability of the road construction by removing the heat. New materials and composites which combine advantageous heat transfer properties with the existing requirements of mechanical behaviour are needed for the optimal use of the available solar radiation. New, multifunctional composites to develop innovative types of collectors are to be tested for this purpose. The process must incorporate considerations of urban requirements in order to develop and achieve an integrated concept for energy use.

The efficiency of a road is greatly impaired by climatic effects. Controlling the temperature of the pavement is one way of counteracting the influences of cold in winter times and heat in summer. What is more, controlling the road temperature saves enormous quantities of de-icing chemicals, an issue which can be especially significant in water conservation areas because of the lower ecological burden.

Different methods of controlling the temperature of the road surface are used in several sections on duraBASt, as explained by Stefan Höller. These sections are fitted with sensor instruments to enable the effect of the temperature control to be traced on the basis of the measurement data.

Illustration 5 - Stefan Höller with the visitors of the World Road Association explaining SEDA Temperature-controlled road

HEALROAD / MLS 30

Dirk Jansen and Bastian Wacker presented the HEALROAD project and the Mobile Load Simulator MLS30. The HEALROAD project was designed to extend the lifetime of wearing courses by using asphalt materials that can self-heal by means of electromagnetic induction. Besides conventional

Illustration 6 - Bastian Wacker on duraBASt to the visitors of the World Road Association

Illustration 7 - Dirk Jansen explaining HEALROAD to the visitors of the World Road Association

components that can be found in asphalt – for example filler, aggregates and bitumen – the HEALROAD mixture contains also conductive components that can be rapidly heated by induction, reducing the viscosity of the surrounding bitumen and boosting it through cracks. As a result, damage produced in the mastic that bonds the aggregate particles is healed and the service life of the road is extended.

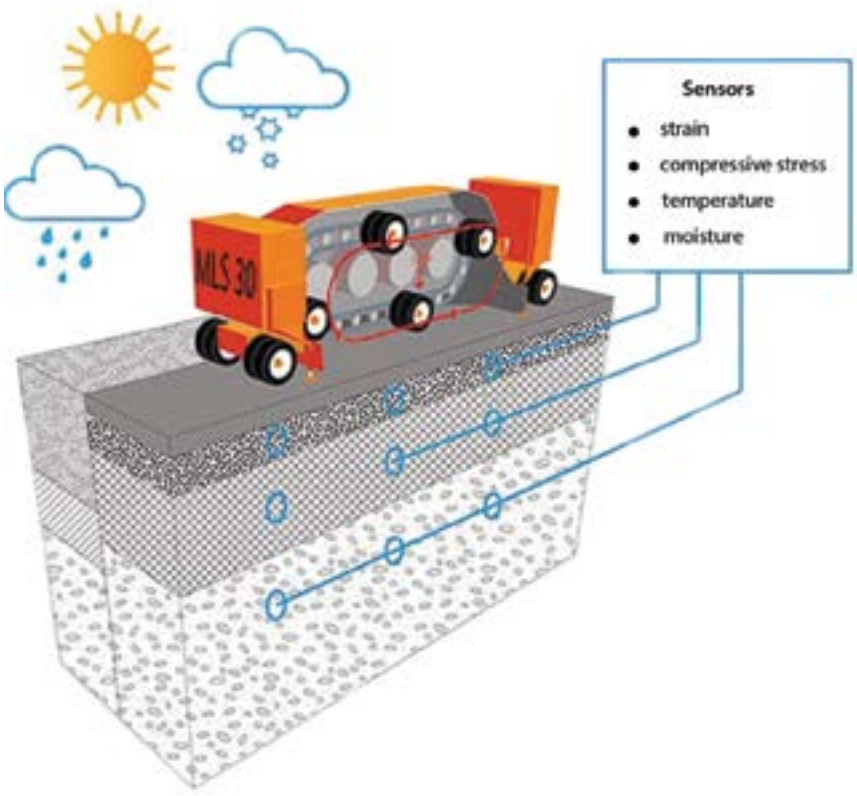


Illustration 8 - MLS30 accelerated pavement testing equipment © BASt

BASt's MLS30 accelerated pavement testing equipment is used at duraBASt to apply realistic heavy loads on full-scale road sections and then evaluate the performance of the proposed material in real conditions.

The international participants of PIARC's technical visit were highly interested and impressed by BASt's activities, appreciating the presentation material to inform themselves about further fields of research. For all visitors coming from PIARC's member countries around the world, the visit at duraBASt was an impressive last point of an intensive and interesting week in Germany.#

South Korea

Innovative Service Area with Three-Dimensional Design Using Overhead Clearance of Expressway

Kang Hoon Lee, Head of the Project Development Office, Korean Expressway Corporation, South Korea
Member of the Executive Committee of the World Road Association

Illustrations © Korean Expressway Corporation

The *'Si-heung Ha-neol'* service area (hereinafter *"the service area"*), utilizing the overhead clearance of expressway designed in three dimensions has operated since November 12, 2017 after a seven-year long period of development and construction. It is expected that this innovative service area will play a role as an oasis in the Seoul Outer Ring Road expressway that has considerably improved the traffic flow of Seoul Metropolitan area.

Illustration 1 - Overview of the Si-heung Ha-neol service area

BACKGROUND

The Seoul Outer Ring Road expressway is an eight-lane road connecting the outer areas of Seoul metropolitan area. Its total length is 127,8 km and the width is 37,8 m. This expressway is also connected to 8 expressways and several trunk roads, so it can disperse and detour some traffic volumes from/into Seoul and adjacent five big cities (Bun-dang, Il-san, Pyeong-Chon, San-bon and Jung-dong). The construction of the first section of the expressway was started in 1988, and average daily traffic volume reaches up to 180,000 vehicles per day.

Despite the high traffic volume in this expressway, few service areas enabling road users to take a rest have been built so far, due to expensive land price of adjacent areas and the many tunnels and bridges of the expressway. Several requests had been made to construct an alternative parking area next to the expressway to prevent driver fatigue. However, it was argued that the parking area could not meet the various needs of drivers due to space and service constraints. In addition, there has been a demand for a safe bus transit service to travel to adjacent areas. In 2010, Korea Expressway Corporation (KEC) considered the development of an innovative concept of a service area which could maximize space efficiency and satisfy those needs and demands.

LOCATION

The decision for the location of a new service area was made by taking important factors into consideration such as sufficient space and distance from other service areas. Therefore, the final decision for a location of the service area was to install it at the southwestern area of the expressway. But only a small parking area could be built on the ground because a pylon and a cemetery plot owned by a family were located in the proposed site. To overcome this constraint, a new design concept of a service area was proposed.

GOING FORWARD

The construction of the service area was completed in November 2017. The project was financed mainly by a private investor. Land acquisition and the site building were implemented by KEC which is a government-owned company, and then the construction works were awarded to a private contractor. For the next 25 years after completion of the construction, the private contractor will operate the service area; then the service area will be handed over to KEC.

TRAFFIC CHARACTERISTICS

Standard passenger cars account for 78% of total traffic volume at the proposed site of the service area. This traffic volume does not change dramatically during the day and the volume increases a little bit on weekend afternoons. Traffic demand around the site depends mainly on short-distance commuter and business trips.

DESIGN

The facilities and stores layout plans were made by taking geographical and road user characteristics into account. The proposed site for the service area was located in the mountainous area adjacent to a residential development planning area, and there was a six-meter high gap between the sites of both directions along the expressway. To make the best use of this feature and to differentiate from the existing service areas, a new concept for the service area, utilizing the overhead clearance of the expressway and connecting both sites of each direction by using a special structure, was introduced to develop the service area designed in three dimensions.

Based on the traffic characteristics, i.e. short-distance commuting and business trips, and on a site feature such as green areas adjacent to a residential area, the facilities and stores layout inside the service area was decided as shown in *table 1*. A facility for long-distance travel was excluded.

The design concept of the service area, with both sides of the expressway linked together, symbolizes harmony. And the service area was also designed to be easily recognized by applying a symbolic and simple concept and avoiding a complex and excessive one.

Illustration 2 - Electronic sign in the parking lot showing how many cars are now parked and can be parked

Illustration 3 - 7 day 24 hours operating convenience store in the service area

The building of the service area consists of three floors and one basement of 46,000 square meters. In the basement, there is a 24-hour operating convenience store. On the first floor: cafés, fast food restaurants, a bakery shop, pharmacy and supermarket. On the second floor: clothing stores, an equipment store, etc. On the third floor, food courts and restaurants.

TABLE 1 - FACILITIES AND STORES LAYOUT

Perspective	Concept	Facilities
Life	Relax and recover from everyday life	Drive-through café, hair shop, medical center, laundry shop, electronic and telecommunication customer service center, supermarket, outlet
Business	Business support	Bank, VIP lounge, meeting room, business center, exhibition and performance floor
Convenience	Essential for road users	Food court, restaurants, regional products store
Relax	Care and convenience for all	Shower room, kids room, nursing room, terrace, observatory, pharmacy

MAIN FEATURES

Utilization of road space designed in three dimensions

In February 2017, the Korean government announced a policy regarding the utilization of road space designed in three dimensions. The idea is to develop a road in harmony with the city, residential areas, cultural sites and transportation. This new service area will be the first concept maximizing the use of the overhead clearance of the expressway to increase space efficiency, thereby reducing the cost of land acquisition to construct the service area and minimizing the damage to the natural environment. To use the overhead clearance of the expressway, a superstructure with sufficient width and prestressed concrete (PSC) beam girders were designed, and measures for structural safety and prevention of vibrations were taken. Vibration proof products were used, such as steel pile foundation and abutment.

Illustration 4 - A bus transit center located in the service area

Illustration 5 - An electric car recharging facility in the service area

Implementation of a public transit system

Since 2010, the Korean government has provided a public transit center for the efficient management of land and the convenience of users. By introducing such a transit center in the service area, people living near the service area can take public transportation or other sharing economy transport types directly at the service area to travel to the airport and other cities. Passengers can save time dramatically by using this transit center, and a parking lot and a bus station have been operating under adjoining bridges to improve accessibility to the service area.

Promotion of sharing economy

In April 2017, KEC signed an MOU with a car sharing company to promote sharing economy, and in the same context, 10 car sharing zones were installed under the nearby bridges of the service area. With the advent of Smart-tolling in 2020, some idle spaces around toll service centers can be transformed into such a car sharing facility.

Introducing an environmentally friendly facility and strengthening a relationship with the local community

The service area is an environmentally friendly service area which has reduced its operation costs by using solar panel facilities. And with the cooperation of the Ministry of Environment, eight recharging facilities for electric cars were installed to increase the convenience of electric car users. In addition, from the early process of the project, there has been a strong communication with local residents and by hiring staff from the local districts, the service area has contributed to job creations locally.#

Spain

Channelized spiral roundabouts with all the permitted movements and the adaptation of the signage

Oliver Marrero Jerez, Civil Engineer, Project Designer, Proyma Consultores S.L.P., Spain

Illustrations © Author

The increase in traffic volume coupled with the general poor use of multi-lane roundabouts is causing the demise of this type of road junction. This is due to drivers' refusal to use the inside lanes as they are harder to access and more dangerous to exit. As a result, they drive around the outside of the roundabout preventing others from exiting from the inside lanes or accessing the roundabout from the various entry points. The multi-lane roundabout therefore becomes congested, turning into a single-lane roundabout with a lower capacity.

Turbo roundabouts are a good alternative as they have a greater capacity and fewer points of conflict. However, the signage is more complex and some movements are limited, such as reversals of direction or access from a secondary road towards another located behind the second channel (on two-lane turbo roundabouts).

DISCUSSION

To enable all manoeuvres on a turbo roundabout, a new transition to the inside lanes can be designed, making it possible to drive all the way around the roundabout.

On a conventional four-armed turbo roundabout with a primary vertical flow and a secondary transversal one, *illustration 1* shows how the central island should be truncated to facilitate the transition to the inside lane.

To achieve this, it is simply necessary to extend the interior radius of the new lane to the point of divergence of the previous exit *(illustration 2)*.

A lateral sign explaining the new movements to be performed is needed for this new design. *Illustration 3* shows the design layout from a primary entry point on the left and from a secondary entry point on the right.

Despite seeming complex, the rules are actually very simple in practice:

- the outside lane will be used for all the destinations located before the first channel;
- the inside lane will be used for all the destinations from the first to the second channel;
- the inside lane and first inward transition will be used for all the destinations after the second channel;
- the inside lane should be used if two lanes lead to the same destination, allowing drivers using the later entry points to use the outside lane.

Illustration 1 – Change of direction from a secondary road on turbo roundabouts with a transition to the inside lane © Reddit.com

The lanes are alternately depicted in black and blue to distinguish more clearly between them. A pattern of white dots is also used as the reflectance of this helps differentiate between the two colours if visibility conditions are poor or people have poor eyesight.

A letter height of H = 2/3 Hb (8.1.-I.C.) has been used due to the large dimensions of these signs. However, if there is enough space, it is best to make words a size that guarantees that they are clearly legible.

A new type of road-marking arrow has also been designed for explaining the manoeuvres to be conducted on simple turbo roundabouts, irrespective

Illustration 2 – Diagram of the channelized spiral roundabout or turbo roundabout with a transition to the inside lane

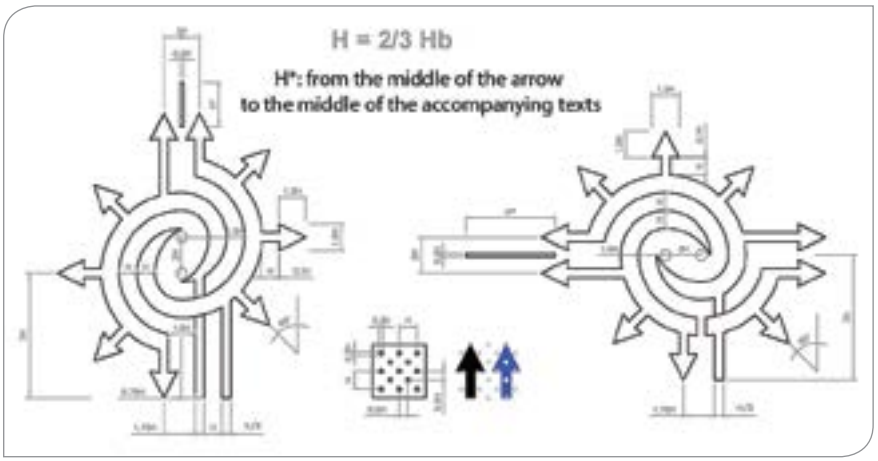


Illustration 3 – Design layout of signs for turbo roundabouts with a transition to the inside lane

of the vertical signs. These also provide additional information if it exists. The arrows have been designed on the basis of those shown in the MUTCD[1] adapting them to meet Spanish law.

By way of example, we will now take a look at four types of turbo roundabouts.

The La Cruz de Piedra roundabout in San Cristóbal de La Laguna, which has four arms comprising three primary arms and one secondary arm *(illustration 5)*. Resolving the situation shown in this example with

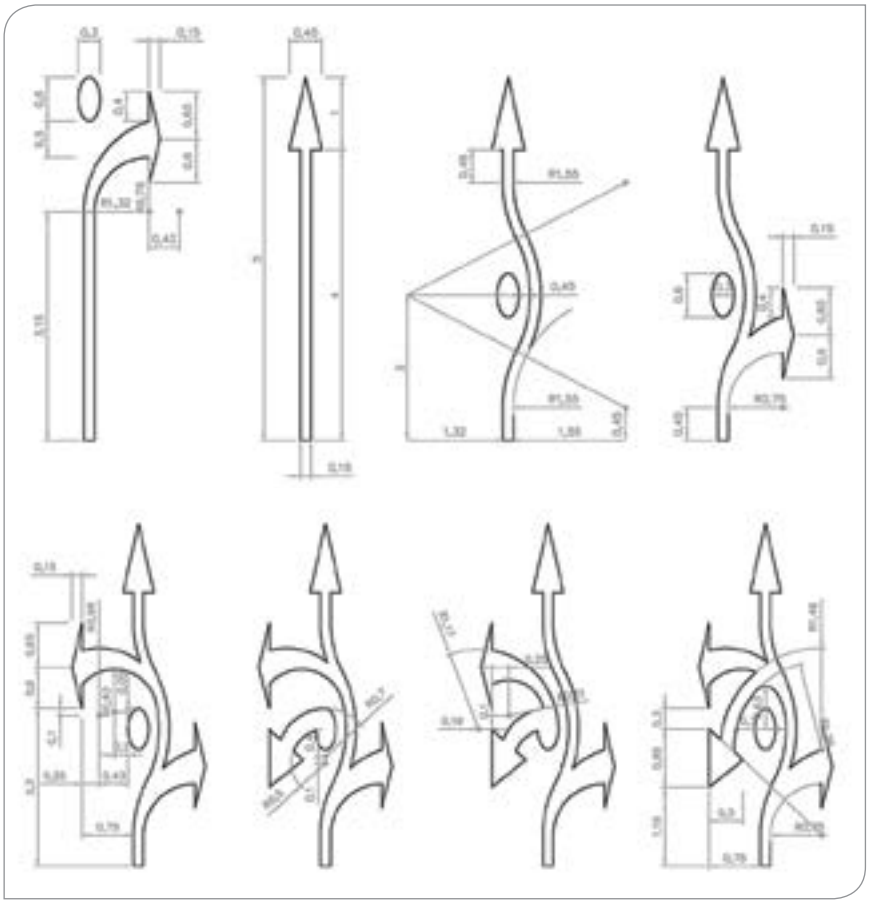


Illustration 4 – Design of the road-marking arrows for turbo roundabouts with a transition to the inside lane

1 U.S. Department of Transportation - The Manual on Uniform Traffic Control Devices (MUTCD). Signs, Chapter 2 - 2009 Edition

Illustration 5 – Channelized spiral roundabout, La Cruz de Piedra

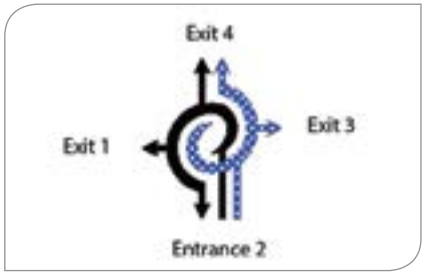


Illustration 6 – Sign on entry point 2, La Cruz de Piedra

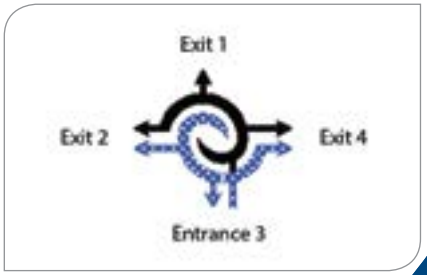


Illustration 7 – Sign on entry point 3, La Cruz de Piedra

Illustration 8 – Channelized spiral roundabout, Av. La Constitución – TF5

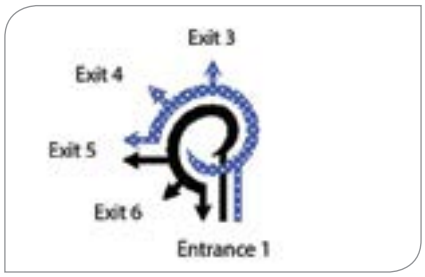


Illustration 9 – Sign on entry point 1, Av. La Constitución – TF5

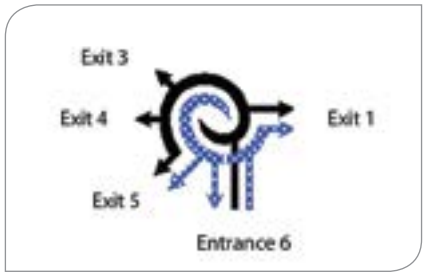


Illustration 10 – Sign on entry point 6, Av. La Constitución – TF5

a conventional turbo roundabout would limit drivers to two or three movements.

Possible manoeuvres when using entry point 2 *(illustration 6, previous page)*:

- destinations 3 and 4 from the right-hand lane;
- destinations 4, 1 and 2 (reversal of direction) from the left-hand lane.

Possible manoeuvres when using entry point 3 *(illustration 7)*:

- exit at 4 using the right-hand lane;
- exit at 4, 1 and 2 using the left-hand lane;
- exit at 2 and 3 (reversal of direction) using the inside lane and transitioning inwards after 90° of rotation.

Illustration 11 – Channelized spiral roundabout, Padre Anchieta

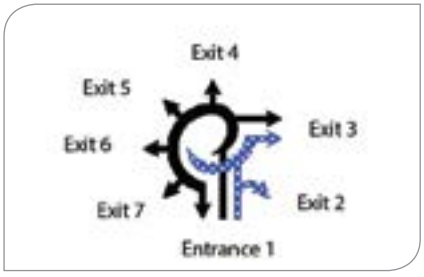


Illustration 12 – Sign on entry point 1, Padre Anchieta

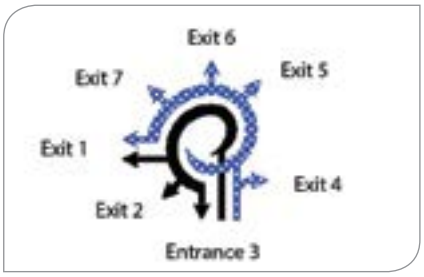


Illustration 13 – Sign on entry point 3, Padre Anchieta

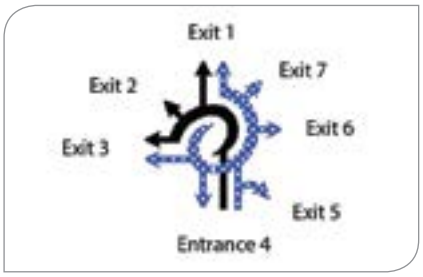


Illustration 14 – Sign on entry point 4, Padre Anchieta

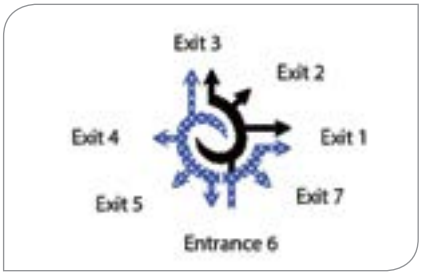


Illustration 15 – Sign on entry point 6, Padre Anchieta

The following example *(illustration 8)* shows a roundabout where the primary entry points are on one side and the exit points are on the other. This is the roundabout that connects Avenida de La Constitución in Santa Cruz de Tenerife with the TF-5

Illustration 16 – Partial hippodrome turbo roundabout with channelized and weaving sections, Añaza

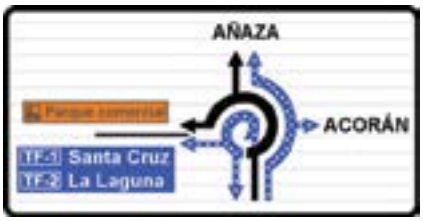


Illustration 17 – Sign on entry point 1, Añaza

Illustration 18 – Sign on entry point 2, Añaza

Illustration 19 – Sign on entry point 3, Añaza

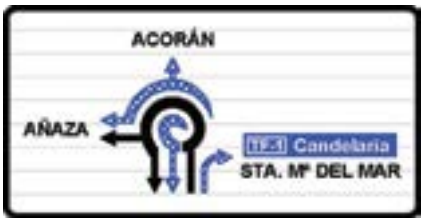


Illustration 20 – Sign on entry point 4, Añaza

motorway and Avenida 3 de Mayo. The high flow of traffic to destinations 4 and 5 overloads the outside lane, leaving the inside lane empty.

Possible manoeuvres when using entry point 1 *(illustration 9)*:

- exit at 3, 4 and 5 using the right-hand lane;
- exit at 5, 6 and 1 using the left-hand lane.

Possible manoeuvres when using entry point 6 *(illustration 10)*:

- exit at 1 from the right-hand lane;
- exit at 3, 4 and 5 using the left-hand lane;
- exit at 5 and 6 using the inside lane and transitioning inwards.

A more complicated example is that of the Padre Anchieta roundabout *(illustration 11)* – a complex seven-armed junction with connections to the TF-5 motorway at two points, Avenida de La Trinidad and several roads and streets. Resolving the situation shown in this example with a conventional turbo roundabout would restrict many of the movements.

Possible manoeuvres when using entry point 1 *(illustration 12)*:

- exit at 2 using a segregated lane;
- exit at 3 using the right-hand lane;
- exit at 4, 5, 6, 7 and 1 using the left-hand lane.

Possible manoeuvres when using entry point 3 *(illustration 13)*:

- exit at 4 using a segregated lane;
- exit at 5, 6, 7 and 1 from the right-hand lane;
- exit at 1, 2 and 3 from the left-hand lane.

Possible manoeuvres when using entry point 4 *(illustration 14)*:

- exit at 5 using a segregated lane;
- exit at 6, 7 and 1 from the right-hand lane;
- exit at 1, 2 and 3 from the left-hand lane;
- exit at 3 and 4 using the transition after 180º of rotation.

Possible manoeuvres when using entry point 6 *(illustration 15)*:

- exit at 7 and 1 from the right-hand lane;

- exit at 1, 2 and 3 from the left-hand lane;
- exit at 3, 4, 5 and 6 using the transition.

The following example shows a junction where there is one road with an elevated traffic volume, with two combined entry points. This is the Añaza circular intersection in Santa Cruz de Tenerife, the problems with which even affect the motorway *(illustration 16, previous page)*.

This is a partial hippodrome turbo roundabout with channelized and weaving sections, enabling the exits and lane changes to be channelized for certain manoeuvres to allow all movements.

The entry points are as follows:

1. Santa María del Mar together with the TF-1 motorway exit;
2. Acorán,
3. Añaza,
4. Añaza business park and connection to the Añaza 2 junction.

There is no transition in this layout; instead, the inside lane becomes the central one after a complete loop. Another feature is the existence of two different destinations for the same direction. These are separated on the diagram by a delimiter line *(illustrations 17 to 20, previous page)*.

The signs are complemented by gantries at the start of the weaving sections.

CONCLUSION

The design of a turbo roundabout with transitions to the inside lane or a channelized spiral roundabout is the solution to the problems with conventional multi-lane roundabouts, improving the traffic flow and reducing points of conflict while also still allowing all movements.

The new vertical signage scheme for lateral signs makes it possible to display more information on how to perform these new manoeuvres in compliance with Spanish law. It furthermore improves the approach of the original design.

The road-marking arrows also provide the information required to correctly use this type of turbo roundabout with up to four arms, making the vertical signs redundant.#

Plaza de Cibeles without channelized spiral turnabout in Madrid, Spain
Fotolia © Ingo Bartussek

User - friendly infrastructure management systems: Saint-Vincent and the Grenadines and Bhutan implementation experience

Illán Paniagua Serrano, David López Oliver, José Antonio Martín-Caro, Gonzalo Arias Hofman,
Ines Ingenieros Consultores (Spain)

Illustrations © Authors

This paper presents a methodology which allows infrastructure assets basic management, without requiring advanced knowledge, based on simple devices and free software. Successfully implemented in two very different contexts (in the Caribbean islands of Saint Vincent and the Grenadines and in the Himalayan region, Royal Kingdom of Bhutan), the following text explains the methodology used to design such system, the experience of its operation, highlighting the obtained results as well as the limitations found. The final purpose of these tools was to provide decision-making advice to infrastructure managers.

INTRODUCTION

The work was conducted in the years 2013 and 2015, under the initiative and supervision of the World Bank. The project names were:

- Saint Vincent & the Grenadines: Hurricane Tomas Emergency Recovery Project and Regional Disaster Vulnerability Reduction Project, 2013.
- Bhutan: Improving the Resilience & Affordabiility of Roads and Bridges, 2015.

Both projects aimed at providing the local Infrastructure Manager with a basic tool, which allowed them to conduct the infrastructure management of their network. This tool needed to increase the assessing capacity regarding periodic maintenance as well as regarding natural hazards and climate change.
The methodology followed in both cases was similar, producing good results despite the different contexts in which they were applied. Such methodology includes the survey, inventory, condition assessment of the road network and associated infrastructure (such as bridges, drainage, cuttings and embankments, furniture, etc.) and the organization/management of data using geographic information systems (GIS).

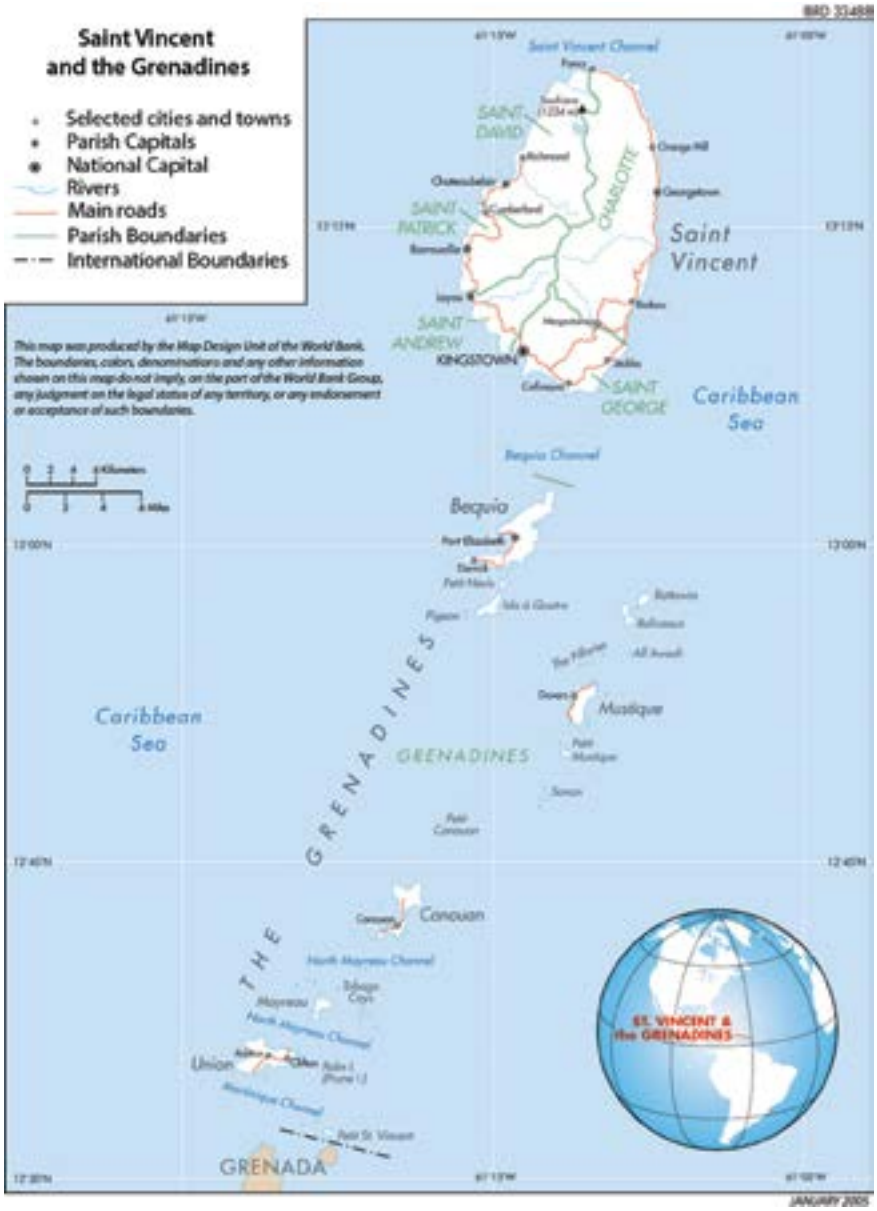


Illustration 1 - Saint Vincent and the Grenadines location © World Bank

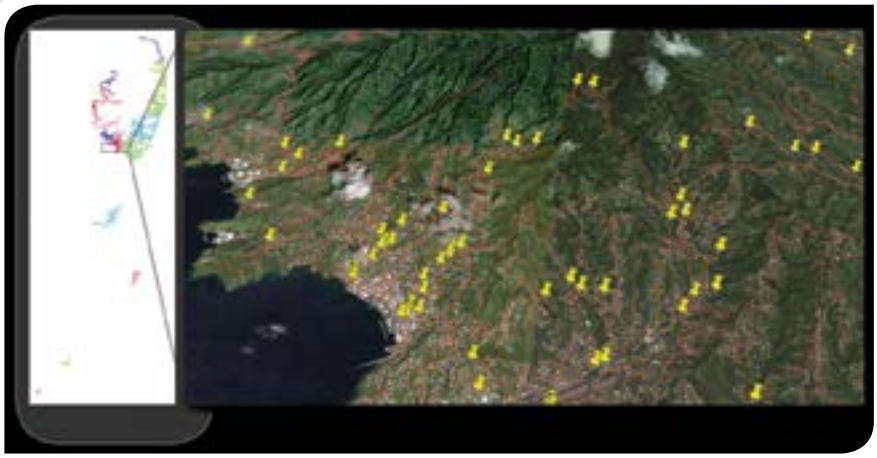


Illustration 2 - Example of GIS file developed for the roads
Zoom in of Kingstown area overlaid over GoogleEarth image
(highlighted in yellow are the different bridges and the red lines show the roads)

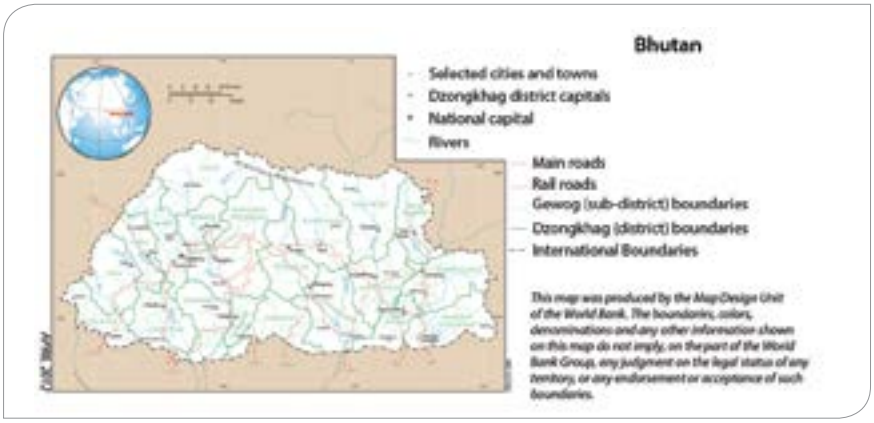


Illustration 3 - Bhutan location, overall scheme map © World Bank

The local staff training and involvement in the various stages was one of the main Projects´ issues, in order to guarantee the knowledge transfer, so the database tool continuity could be ensured.

THE IMPORTANCE OF ROAD NETWORK ASSET MANAGEMENT

Having a broad register of the road networks and the associate infrastructure thereof is an absolute key factor, in order to ease an effective monitoring of the current state, deficiencies and improvement possibilities of the land communication links.

The first fact is that it is unlikely that developing countries develop as quickly or as widely without good connectivity, as road haulage represents a great percentage of freight and goods traffic. At the same time, these countries have a limited infrastructure network.

Moreover, poorly maintained road and bridge infrastructure is inherently more vulnerable to natural disasters, which can unexpectedly sever connectivity and work against development. This fact is of utmost importance in countries subject to recurrent climatic disruptions such as St. Vincent.

The high cost of roads must also be taken into account. All governments are fiscally constrained and have competing priorities (e.g. health, education, defense, etc.). It is therefore important that investments in road and bridge networks use money efficiently by being well timed and well targeted. This requires good asset knowledge and organization.

Saint Vincent & the Grenadines: Hurricane Tomas Emergency Recovery Project and Regional Disaster Vulnerability Reduction Project, 2013

The Project scope included 366 buildings, 815 kms of roads and their associated infrastructure, which included 200 bridges. The contract overall duration was of four months.

Bhutan: Improving the Resilience and Affordability of Roads and Bridges, 2015

The Project involved the development of a management system, which could generate Google Earth files. The database mentioned had to have the information corresponding to the 2,000 km of Bhutan's Primary roads, leaving the secondary network to be implemented by the Department of Roads personnel.

The 2,000 km of roads were surveyed in one month. Over 300 bridges plus numerous slopes and cross drainages were found due to the particular orography of the country.

METHODOLOGY

Database design. Conditions and starting point

In either case, there was no previous infrastructure management system and almost no inventory information. Therefore, the database required to be designed from scratch, with the condition of being easy to manage and using only the basic Microsoft Office package and free software.

Excel format was chosen for its development and attributes were associated to geographical coordinates to allow further management with Geographical Information Systems (GIS).

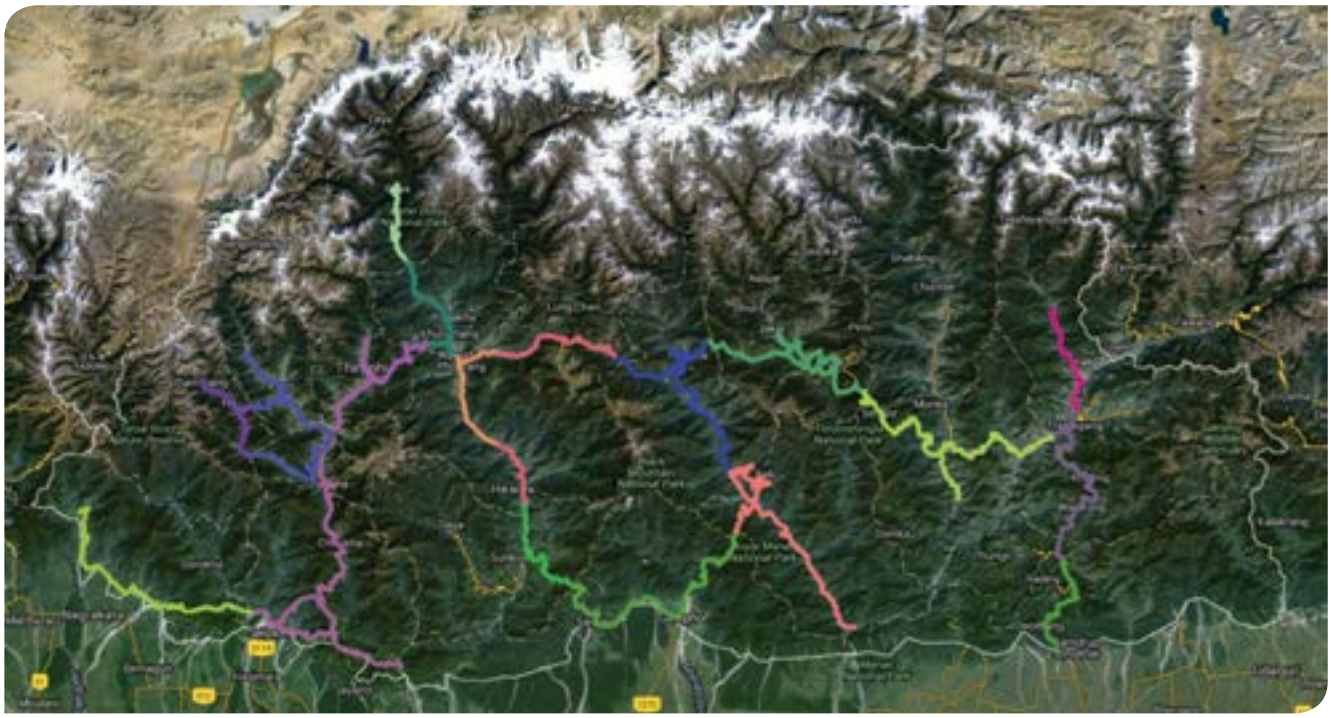


Illustration 4 - GIS file highlighting the main road network per district, overlaid on a Google Earth image

For the database definition, besides conducting a field survey of a representative portion of the road network, in both cases, the team had to meet the people from the final Client currently in charge of the infrastructure management, who shared a general overview of their network and of the main problems they experience.

Coding of inventory items

Road assets coding is considered especially important for the identification and information management of the road networks. With this purpose, a study based on the hierarchical system governing the road network (dendritic, radial, etc.) was performed, establishing a coding structure and function according to its importance in the network code.

Database design

The database was designed associating to each road km point the information not only of the road but of its associated infrastructure, if any.

The database fields were grouped into the following categories:

- general survey information: date, surveyor name, etc.
- general information regarding the road: geographical coordinates, km point, road code, road name, district name, type of road, material, width, etc.
- maintenance information: several fields were defined to record information generated by the organization in charge of the infrastructure management such as: frequency of inspections (from which the next survey is obtained), interventions carried out, investment undertaken in the last years and investment required for the coming years, location of the information, etc.
- operation information: this section included fields directly involved with the daily operation of the road, which register the road condition, its operability and risks against different possible events that can cause traffic disruption, sign postings, crash barriers, traffic peak, etc.

This information structure was followed for all the infrastructure elements associated to the road, always referenced to the road kilometer point in which they are located.

It is worth highlighting that every field of the database has a menu to display, with the different possibilities that may apply so the surveyor just needs to select the corresponding one for each case, unifying the information and reducing errors.

Field data collection

Field surveys are needed for collecting the information that populate the database and which are used by the Chief Engineers to make maintenance investment decisions. Such surveys were undertaken using devices that allowed linking the collected information to a GPS signal (video cameras, tablets and picture cameras).

The devices configuration allowed obtaining a reference point every 5 meters, when circulating at speeds of 30-35 km/h.

The road general survey was combined with the survey of the other infrastructure elements (bridges, drainages, earthworks), being

Illustration 5 - Bhutan's inventory items: 2,000 km of roads, bridges (300 units), associated earthworks, retaining walls and drainage

planned according to the network distribution.

Both cases exposed in this paper allowed a similar performance of 35 to 50 km per day, depending on the state of the roads and the amount of structures in the surveyed section.

The field surveys collected a big amount of information, which required an extensive dedication for its processing. GPS data was directly exported into the database, which as mentioned above, was used to refer all the collected information to a position.

This process requires an efficient information management, for which it helps having codified and defined the different possible options for each database field. Having performed this allows reviewing the suitability of the information before it is loaded into the database, at the same time that it helps getting uniformity in the population process, allowing several teams to work at the same time with the same criteria. Both projects required a Quality Control verification, which this system allows thanks to its capacity to display the database with GIS software and contrast the accuracy and quality of the information collected.

Management System

Both systems are based on an Excel database displayed with a GIS software. Besides allowing the organization, storage, analysis and modeling of the infrastructure data, they are compatible with other software and enable visualizing the information with: Access, SQL, Oracle, Google Earth, AutoCAD, etc.

From a single database, besides the common operations that Excel allows (graphs, statistical operations, diagrams, pivot tables, macros, etc.), a series of general and thematic maps can be generated over which different layers can be managed and easily exported into Google Earth, Autocad and other databases. This allows managing the road network information by linking it to its location, which provides a very useful overview of the network status and enables managers to obtain an approximate budget estimate for the maintenance operations.

The database enables risk studies by combining this data with thematic maps representing a set of risks (flooding, seismicity, volcanic risk). As result, the impact of the different possible events can be foreseen and measures can be defined in order to minimize it.

Training of Managers and Surveyors

The methodology was completed with the drafting of manuals and courses of theoretical and practical training (data collection, thematic maps, query routines, compatibility with other programs).

CONCLUSIONS

The implementation of this methodology has allowed by simple means and conventional or free software to obtain and manage a database, which contains the information of the current state of the network. In both cases, the methodology has been adapted/ customized efficiently to local conditions and uses of each manager.

Illustration 6 - Data collection undertaken in St. Vincent (top row) and in Bhutan (lower row)

The data collection in the field with conventional GPS equipment (cameras and tablets) made possible obtaining a spatial reference to which inventory data can be linked. Its low cost, high performance (700 km / month / equipment) and reliability have not presented any problem regardless of the location conditions, making it particularly convenient for developing countries.

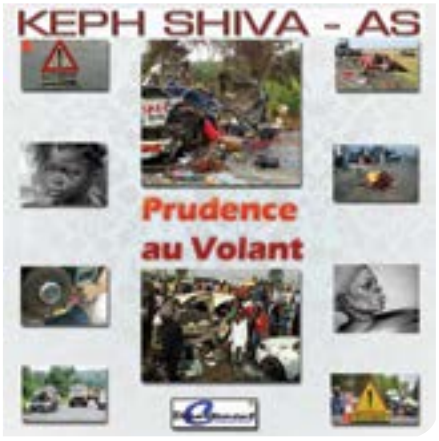
The implementation of data using Excel has been positive because it allowed an easy management: entering and editing data tasks, sharing file copies, using formulas, graphics and combined queries regardless of the user´s level.

Exporting data to a GIS system has enabled: the georeferenced display of stored data, a faster query speed, the performance of combined queries and exporting the results to other programs (Google Earth, Autocad, etc).

The main disadvantage is the low automation of the database population.

Finally, it is worth pointing out that the generated databases have allowed the creation of the basis for a maintenance history of the infrastructure elements corresponding to the road network of these two countries. Its management allows the identification of critical situations for the operating conditions. At the same time, it allows prioritizing interventions, estimating costs and creating strategies for maintenance planning of road infrastructure, being compatible with the study of the impact of natural disasters and vulnerability to climate change.#

SPOTLIGHT ON YOUNG PROFESSIONALS



Tenghi Kamga, alias Keph Shiva-as, 34 years old, artist (Cameroon)

When did you start to work in the transportation sector?

It's not my typical area of activity. I'm a singer and wanted to get involved in helping my country, Cameroon, in its efforts to improve road safety. The nation's authorities are backing my initiative.

What attracted you to this field in particular?

I'd like to see the number of road accidents in my country drop. I feel it's a moral responsibility for all citizens, and even more so for an artist citizen like myself, to play a role.

In specific terms, what does your action entail?

I wrote a song called «*Prudence au Volant*» (Caution behind the Wheel) in the aim of reaching out specifically to a young audience still in school. This song serves to galvanize a project to host a concert tour in schools and universities, during which awareness-building about appropriate road behavior will be promoted and explained.

The originality of this project is to empower the target population segment to effectively defend good driving behavior. As future motorists, public transit users or even as pedestrians, these young people are constantly exposed to the risk of an accident.

The initiative strives for consistency. It is based on the conviction that Africa's urban youth must learn to distinguish between right and wrong road behavior. The chaos endemic in our cities doesn't need to be belabored any further. These young people are growing up in such an environment and if nothing is done, they'll assimilate this current state as entirely normal.

What values are important to you that you found during this prevention campaign?

With a background in public policy, I strongly emphasize pragmatism, rationality and intellectual rigor. In pursuing my activities, my motto remains Discipline and Work. That said, I did have to push this project completely on my own for the most part, despite the urgency surrounding such an initiative.

How do you publicize your project?

I recently published the song «Prudence au Volant» on the majority of respected online music platforms. The feedback I've received has been quite moving, especially given that the words of praise and encouragement come from folks I've never met. This has inspired me even more and given me hope that the project I'm sponsoring will produce the desired effects.

In your opinion, what are the leading challenges that the transportation sector must face going forward?

The number one challenge lies in streamlining the road accident prevention effort, which encompasses three imperatives: discipline exercised by prevention actors in the field; (continuously) enhanced road user awareness; and institutionalization of the «*Zero tolerance*» notion.

The second challenge is to promote originality in the awareness-building campaigns underway. Unfortunately, for the time being, they are neither aggressive enough nor fully cognizant of the level of risk severity.

The third challenge has to do with bridging road accident prevention with other initiatives, since for now efforts are largely taking place within a vacuum.

How do you see your initiative evolving?

This project has a built-in national dimension. For starters, we chose the city of Douala as a pilot site but are definitely hoping that the interest shown by our potential partners will allow us in time to cover all of Cameroon.

From a more personal perspective, I anticipate in the long run transforming ***Prudence au Volant*** into an organization oriented toward educating students both in schools and universities about appropriate road use. This organization would also be in a position to offer scholarships for targeted youth, fulfilling all the legal conditions, to enter driving school in the aim of obtaining a driver's license.

«*Prudence au volant*» (sung in French) available in free streaming on: ***www.soundcloud.com/keph-shiva-as#***

Road safety: Policies, strategies and action campaigns

Laurent Carnis, Research Director, IFSTTAR Institute, France

French-speaking Secretary of Technical Committee C.1 *National Road Safety Policies and Programs* of the World Road Association

Background, Fotolia © Sergey Novikov

Laurent Carnis

The internationalization of the road safety issue is no longer open to debate. Road-related risks must now be addressed across all continents, although the extent of risk mitigation varies tremendously. Should the numbers of victims be expressed per capita or should analyses actually segment by victims, major variations can indeed be observed. Such discrepancies are known to decision-makers, as underscored by Roberto Arditi, in his introduction on low and middle-income countries.

The phenomenon of unsafe road conditions is thus widespread, with similar tendencies found from one country to the next: driving at excessive speeds, vehicle operations despite diminished capacities or even incompetence, inappropriate vehicle uses, safety features inadequate or missing altogether, as well as faulty road infrastructure amenities and in some cases the complete lack of a secure road environment.

The focus then lies on organizing the «*great escape*», in the words used by A. Deaton, 2015 Nobel Prize-winning economist, to describe civilization's progress in the areas of public health and anti-poverty programs. Such an escape now needs to be organized for the effort to improve road safety, which requires building awareness at the highest levels, as witnessed by the United Nations' implementation of a whole decade of road safety actions.

Decreasing the number of road accidents entails mobilizing both human and financial resources, in addition to sharing best practices and proven solutions. Knowledge dissemination to as wide an audience as possible has therefore become a key road safety challenge. The World Road Association Road Safety Manual ***(road-safety.piarc.org)*** and its recent update have provided a partial response, as noted in the article by S.V. Wong.

This special issue serves to consolidate the safety improvement effort; it has been assembled around a selection of contributions presented during the World Road Association' seminars. Such gatherings constitute valuable forums for sharing and exchanging current practices. The various articles contained herein span the continents and convey genuine expertise. The editorial angle has been to promote papers submitted by low and middle-income countries, as a means of highlighting their challenges along with a certain optimism gained by exposing knowledge acquired plus some solid expertise.

The contribution by R. McInerney, B. Tuner and A. Barlow demonstrates how a road network rating system based on audits has yielded a powerful instrument for improving road safety results. An application of this approach to the Mexican case is presented by A. Mendoza and M. Cadengo. D. Schmitt explores how inspection and audit tools designed for pedestrian infrastructure safety have shown promise in helping protect vulnerable road users. The deployment of such tools has necessitated, among other steps, inserting safety objectives into both an integrated approach to organizing mobility needs and the successful execution of an urban planning strategy. L. Carnis pays close attention to detail during the prioritization and evaluation steps dedicated to road safety policies and action campaigns. Such prioritization requires even greater emphasis in the presence of multiple challenges, as revealed during the interview with H. Gomez on road safety conditions in Latin America. Contributions specific to vulnerable users by S. Robertson for South Africa and S. Wong, A. Poi, M. Amirudin and M. Radzi for Malaysia also offer pertinent and illuminating testimonials on the magnitude of problems faced and their potentially effective solutions.

Thanks to this special issue entirely devoted to road safety, the reader is invited on an extensive trip to discover the various manifestations of road safety challenges. Beyond the exoticism such a trip is bound to deliver, this issue is intended first and foremost as a call for action and an encouragement for readers to get involved!#

From the UN Road Safety Resolution to the World Road Association's Action

Roberto Arditi, Director of Scientific Affairs at SINA, Italy
Chairman of Technical Committee C.1 *National Road Safety Policies and Programs* of the World Road Association
Illustration © Author

It is known worldwide that according to UN estimates, road accidents result in 1.25 million fatalities per year and up to 50 million injured people all over the world. Over 90% of deaths are registered in low and middle-income countries. The awareness about this kind of problem led Member States represented in the United Nations General Assembly to opt for a Decade of Action for road safety (2011-2020), the declared aim of which is stabilizing and then reducing road traffic fatalities and injuries at a global level.

Roberto Arditi

On April 15th, 2016, the UN General Assembly and its Member States adopted resolution A/70/L.44 on *"improving global road safety"*. This resolution was co-sponsored by 55 national governments.

The resolution reaffirms the adoption and implementation of the Sustainable Development Goals even in the field of road safety, as outlined in the 2030 Agenda for Sustainable Development. Especially Sustainable Development Goal n° 3.6 aims at halving the global road traffic deaths by 2020. Moreover, Sustainable Development Goal n° 11.2 aims at providing by 2030 a safer, more efficient and sustainable transport system to everybody in the world.

The resolution acknowledges the importance of these targets and calls for actions to reduce road traffic deaths and injuries: it was in fact considered that this kind of action is a pressing development priority. To perform this action the resolution also endorses the outcome document of the 2nd Global High-Level Conference on Road-Safety, held in Brazil in November 2015, namely the *"Brasilia Declaration on Road Safety"*.

ACTION OF THE WORLD ROAD ASSOCIATION'S TECHNICAL COMMITTEES

Technical Committee C.1 *Road Safety Policies and Programs*, since its first meeting after the resolution (September 29th, 2017), started to take in charge this resolution. In fact, the mentioned A/70/L.44 is quite relevant to the World Road Association' activities: the resolution acknowledges the World Road Association's Road Safety Manual ***(http://road-safety.piarc.org)*** as *"an important international effort on road safety to offer guidance to officials at various levels on measures that can enhance the safety of road infrastructure"*. Such an institutional acknowledgment does not only draw attention to the World Road Association's Manual but it also becomes a demanding task for all international experts of the World Road Association who are in charge of the manual evolution.

The Rome meeting of September 29th, 2017 was even the opportunity for the establishment of the Steering Committee created for the Manual which will lead the evolution, dissemination and development of proper strategies for the education of the involved human resources.

Besides a selection of Committee experts, the representation of global Institutions - the World Health Organization, the OECD, the United Nations-ECE - as well as of the bodies financing roads worldwide, such as the World Bank, the European Investment Bank, the Asian Development Bank, the Inter-American Development Bank, have been invited to contribute to activities of the Steering Committee.

A SHARED COMMITMENT FOR ROAD SAFETY

It is largely recognized that serious injuries in road accidents can be mostly prevented, often even predicted in general terms. An accident is something human-related, and the road transport system can be rationally analyzed and effectively managed in terms of progressive improvements. Road transport systems, including vehicles, infrastructures, human factors, choice of allowed

Illustration 1 – TC C.1 meeting in Rome

speed limits, can be developed in such a way to reduce fatal accidents probabilities and minimize serious injuries when accidents occur.

This international orientation is supported by knowledge on how to achieve significant reductions of the negative consequences due to road traffic, consequences which are ethically not acceptable, even before considering their cost. In this regard, the countries of the European Union are a good example.

The overall volume of road traffic has tripled over the period 1970 to 2000 while the number of road deaths has fallen by 50% per million inhabitants. In the last 20 years, new approaches have introduced a change in the overall frame for handling road safety and they have contributed to set new challenging goals.

The long-term goal of a safe system approach to road safety is the reduction towards zero for fatalities and serious injuries supported by medium-term quantitative targets of reducing accidents (OCSE, 2008). The basic principle is to implement a system able to minimize road deaths and serious injuries, though accepting the possibility that accidents with less serious consequences occur. As a matter of fact, the road safety system ethic objective proposed a new definition of what *"safety"* means as to the goals of the road management system and of its related elements (design and construction of vehicles, of infrastructures, etc.).

The general road safety strategy aims at guaranteeing that, in case of accident, the forces unleashed by the crash and impacting on people do not exceed the limit above which deaths or serious injuries may occur. The aim is to start taking into consideration the known human features, the unintentional human mistake and take into major account the vulnerability of the human body when planning, designing, implementing and using the road system, for the safety of all road users.

The actions on the road safety system obviously involve all the road traffic system parts, namely infrastructures, vehicles, medical emergency services, education of road users.

The target of zero is unrealistic in the short period. However, the important improvements in the European continent, on European motorways, clearly prove that approaching this utopian goal could be possible by setting proper medium/long-term targets and thanks to the technical, technological, organizational and cultural improvement we will be able to promote. It opens also new hopes and opportunities for low and middle-income countries.#

Design and Operations of Safer Road Infrastructure

Shaw Voon Wong, Director-General, Malaysian Institute of Road Safety Research, Malaysia
Chairman of Technical Committee C.2 *Design and Operations of Safer Road Infrastructure* of the World Road Association
Illustrations © Author


Shaw Voon Wong

Safe design and operation of road infrastructure covers a very broad scope. To get results delivered within the work cycle, PIARC Strategic Plan 2016-2019 has put forward 5 specific issues, and TC C.2 *Design and Operation of Safer Road Infrastructure* has been formed to look into these issues and deliver possible technical contents and materials that would enhance the PIARC Road Safety Manual (RSM). The issues pertinent to vulnerable road users, driver distraction and fatigue, and how human factors should be considered in road design and operations. TC C.2 is expected to contribute to the revision of RSM and also the possible revision of the Road Safety Audit Guidelines taking into considerations of applicability in low and middle-income countries.

Besides delivering technical materials, TC C.2 is expected to look into possible materials for promoting the use of RSM in solving the said issues. The first issue is to investigate and further develop technical and promotional materials related to vulnerable road users, which includes pedestrians, cyclists, motorcyclists and elderlies.

It is a new perspective for road engineers to incorporate human factors into the design and operation of road networks. Techical Committee C.2 is given the responsibility to develop a good number of case studies and successful strategies


Illustration 1 - Members of Technical Committee C.2 - Design and Operation of Safer Road Infrastructure, during the 1st TC Meeting in Paris (France) 2016

and practices in design and operation by considering human factors including driver distraction and fatigue. The case studies would be proposed in the upcoming RSM update. Practical training sessions were organized during the 2nd TC meeting in Florence (Italy), which has widened the horizon on the importance of human factors in road safety for the TC.

The third issue put forward to the TC is to assess the available efforts by numerous international organizations, such as the World Health Organization (WHO), the automobile industry, the UN Economic Commission for Europe, and the World Bank, on how to set credible speed limits. Collaboration is being explored if necessary to develop such guidelines as the output of this would be considered as part of the RSM update. Technical Committee C.2 is also seeking to develop communication material in disseminating such to PIARC members.

The TC is required to compile a catalogue of safety problems and potential countermeasures in safe design, operations and maintenance of road network in low and middle-income countries. This is particularly important as not all initiatives work well in every corner and the precious

Illustration 3 - Support to #SlowDown for the Global Road Safety Week during the 3rd TC meeting in Santiago (Chile), 2017

Ilustration 2 - Training Workshop on Human Factors in Road Design during 2nd TC meeting in Florence (Italy), 2016

experience in low and middle-income countries is often not thoroughly documented. The compilation would be incorporated into the update of RSM.

The last issue included in the Strategic Plan for TC C.2 is to review the existing Road Safety Audit Guidelines. Specifically, the TC is asked to consider applicability of the Road Safety Audit Guidelines to low and middle-income countries with possible enhancement and extension of the present guidelines. A dedicated workshop on Road Safety Audits was organized by the TC with the support of the Development Bank of Latin America as a parallel session to the 2nd International Congress of Road Safety in Santiago (Chile) in 2017. It was back-to-back with the 3rd TC C2 meeting. Inputs and experience from Latin America were gathered and road safety audits were promoted to a large extent in the region.

Road Safety is an important agenda in PIARC. It has been one of the main focuses throughout multiple work cycles, and as stated in the 2016-2019 Strategic Plan, the evolution and development of such is expected to be carried further into the next work cycle. The comprehensive RSM is now treated as a living manual and would enable updates and amendments according to the most recent development in road safety globally. Specific issues were identified and are being addressed by the TCs, in enhancing the RSM and maintaining its relevance to the practitioners, including those from low and middle-income countries. PIARC and the Technical Committees are looking forward to a wider adoption of the technical contents in the RSM at various levels in solving Road Safety challenges.#

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Road Infrastructure: A Key Building Block for a Safe System

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THE FOUNDATION FOUNDATION FOR A SAFE SAFE SYSTEM

The interaction between road users is ultimately determined by the design of the road infrastructure. The road provides the foundation for transport and mobility and also provides the foundation for a Safe System if it is designed, built and maintained well.

Fatalities and injuries are the outcome of the design of the system at the infrastructure level. Pedestrians and cyclists interacting with high speed vehicles; vehicles crossing each other at intersections; vehicles running off the road and hitting trees and poles or running down steep embankments; and vehicles hitting each other head-on at high speed can all be fatal or result in serious injury. The potential for these types of conflict are determined by the design of the road.

OECD (2016) suggest the key Safe System principles are:

1. people make mistakes that can lead to road crashes
2. the human body has a limited physical ability to tolerate crash forces before harm occurs
3. a shared responsibility exists amongst those who design, build, manage and use roads and vehicles and provide post-crash care to prevent crashes resulting in serious injury or death
4. all parts of the system must be strengthened to multiply their effects; and if one part fails, road users are still protected.

MEASURING SAFETY ON EXISTING ROADS

The measurement of safety on existing roads involves the analysis of crash data and the inspection of road features to determine where safety issues exist and how they can be addressed (PIARC, 2017). This may include crash-based analyses, crash prediction models, road safety audits and inspections, network surveys and star ratings of roads. Ideally, it should involve all of these methods.

CRASH ANALYSIS

The traditional approach to road safety has been to treat high risk locations based on crash history (PIARC, 2013). The analysis requires a sound theoretical approach that addresses statistical variance, trend data, control sites and consideration of data quality and other issues (Sorensen, Elvik 2008).

Treatments effective in reducing specific crash types are then used at locations where there is a high incidence of crashes (PIARC, 2009). Evaluations have shown this approach to be highly cost beneficial. As an example, an evaluation of the black spot program in Australia has demonstrated a benefit-cost ratio (BCR) of 7.7 (BITRE, 2012).

Although the crash based approach to risk assessment and treatment will continue to be of value, a recent study from New Zealand and Australia (Turner, 2007), found only a third of fatal crashes were identified as occurring in 'black spots', and more than half of the sites had no other crashes over the previous 5-year period.

ROAD SAFETY AUDITS, INSPECTIONS AND STAR RATINGS

The formal road safety audit of designs and road safety inspection of existing roads is now well established. The systematic review of road design provides for a proactive identification of safety issues that are known to contribute to the likelihood and/or severity of a crash.

The World Road Association has published a comprehensive guide to the completion of road safety inspections (PIARC, 2012). The needs of different road types are recognised and a series of example reports provided to guide inspection teams.

An extract of an example inspection is provided *table 1*:

Illustration 1 - Mexico Star Rating 2012 & 2015 (45,000 km) (top); Australian Star Rating 2013 (22,000 km) (bottom)

NETWORK-LEVEL INSPECTIONS AND STAR RATINGS OF ROADS

Network level inspections are especially useful when crash data is unavailable or unreliable, or in the case of high-performing countries where crash frequencies are insufficient for a crash-based analysis. This risk based approach also supports the Safe System approach to managing the road network.

Star ratings are based on the road engineering features and are produced for vehicle occupants, motorcyclists, pedestrians and cyclists reflecting the different infrastructure needs of each of these users. One-star is the least safe and five-star is the safest. An assessment of star ratings from 20 countries covering 100,000 km identified more than half of all roads assessed were only rated as one- or two-star for all road users (McInerney & Urzua 2013).

In general, validation studies suggest crash costs are approximately halved for each incremental improvement in star rating as detailed in the Australian analysis below (McInerney & Fletcher, 2013).

ENSURING SAFETY OF NEW ROADS

The application of appropriate design standards that account for Safe System principles is critical to the reduction of death and injury on the world's roads. With road crashes being one of the biggest killers of young people worldwide (WHO, 2013) the acceptance of historical design standards must be challenged and the original research behind various warrants for safety features challenged and updated.

Ensuring road design meets the needs and expectations of communities, and the United Nations as part of the

TABLE 1 - EXTRACT FROM A ROAD SAFETY INSPECTION (PIARC, 2012)
Result of road safety inspection on 4th July 2006 on the national road 20B from km 229 to km 234 (Vietnam)

5. Service and rest areas and exit lanes	• There is no petrol station along the road section. • There is a rest area at Minh Tam park. • At some places there were exit lanes.
6. Public transport	• There are no bus stops on the whole route even though there is public transport and buses, especially minibuses are stopping everywhere.
7. Needs of vulnerable road users	• There are only sidewalks in the urban area. • There are no safe pedestrian crossing, not even at the school
8. Traffic signing, marking and Lighting	• The traffic signings are insufficient and not clear enough; the markings tend to be damaged at some places. • There are no curve chevrons (not regulated in the Vietnamese guidelines for traffic signing) • There is no signing at the entrance of the built-up area. • There are rumble strips at the beginning of some curves. • The dimension and construction of the delineators is not standardized.

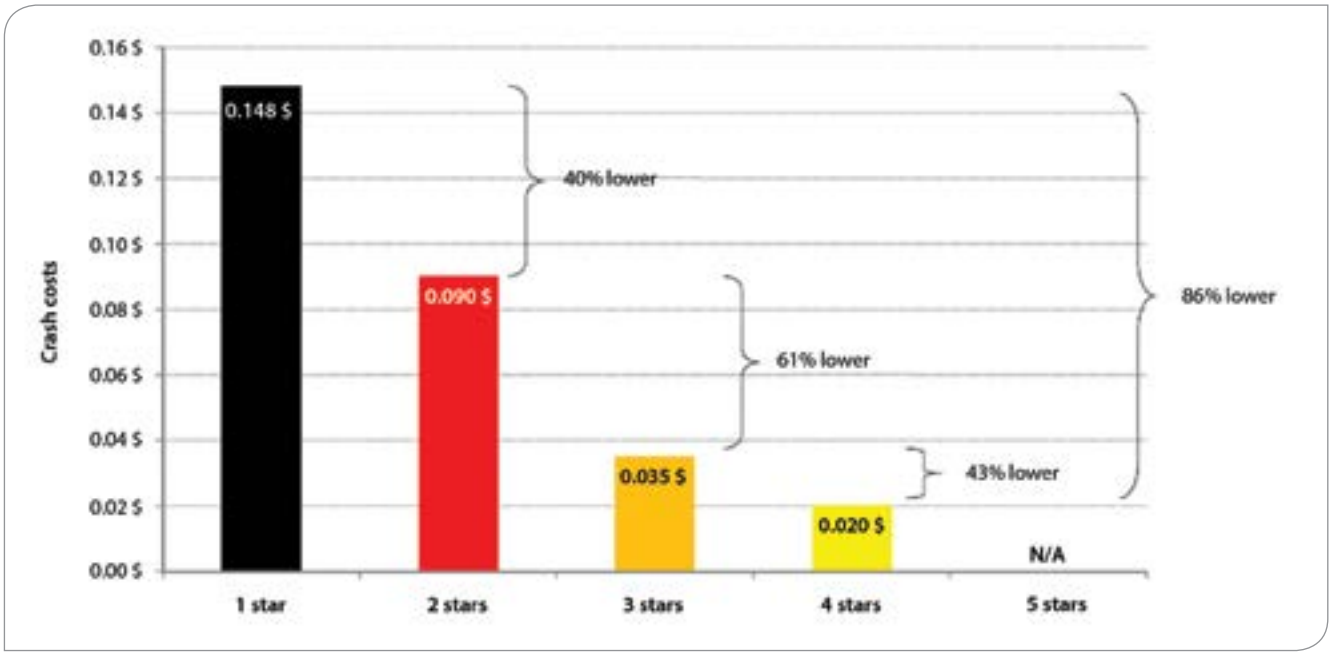

Illustration 2 - Star Ratings and Crash Cost per vehicle kilometre travelled © McInerney & Fletcher (2013)

Decade of Action for Road Safety, is important to ensure new poorly designed roads are not built.

The standards review should start with the needs of the most vulnerable, and the design process should also follow a similar philosophy. By first providing for the safety needs of pedestrians and vulnerable users in a new design, then motorcyclists, cars and heavy vehicles, will ensure the road space is allocated to maximise safety and not just speed and travel time, which often has a negative impact on safety if not designed to the appropriate safety level.

MINIMUM STAR RATINGS

The widespread use of Star Ratings for road infrastructure has now made it possible to set and apply minimum star ratings for new road designs. The UN Secretary General's report on Improving Global Road Safety recommends star rating targets for all relevant road users should be set for the highest volume 10 per cent of existing roads, and minimum three-star standards and road safety audits established for all new road construction (UN General Assembly, 2015).

A case study where the use of minimum star ratings for new road designs was undertaken as part of the Karnataka State Highway Improvement Project (KSHIP) in India was presented by the Commission for Global Road Safety (Make Roads Safe, 2013). It was estimated the new designs will result in 55% fewer deaths and serious injuries than currently occur, equivalent to over 1,400 deaths and serious injuries saved every year on just 550 km of road.

A similar project in the Republic of Moldova produced similar outcomes as part of an initiative supported by the Millennium Challenge Corporation. The design reviews particularly focused on pedestrians in villages increased the percentage of road rated 4-stars from 8% to 84%. Final designs were estimated to reduce risk of death and severe injuries by 40% (Make Roads Safe, 2013).

THE BUSINESS CASE FOR SAFE ROAD INFRASTRUCTURE

iRAP (International Road Assessment Programme) assessments completed worldwide were used to estimate the country by country and global return on investment from targeted road safety infrastructure upgrades on the highest volume 10% of roads (iRAP, 2013). The summary analysis is provided in the table below and demonstrates that an investment of between 0.1-0.3% of GDP per year in a dedicated Safer Roads Fund can save an estimated 40 million serious injuries and deaths over the 20-year life of the road treatments with returns on investment as high as 14 to 1 in upper middle income countries.

FINANCING ROAD SAFETY UPGRADES

Having built the business case for safer road infrastructure, the funding remains a priority to ensure life-saving treatments are implemented. Achieving ambitious safety targets requires the use of current resources is made more efficient through better targeting of action or through better policies and procedures (OECD, 2008). The OECD report goes on to outline the traditional financing sources including general tax revenues, road funds, user fees, insurance levies and earmarked charges and how they are applied in various countries such as Great Britain and the Netherlands.

	★		★★		★★★		★★★★		★★★★★		Total
KSHIP Annuity Road – Existing	0 km	0.0%	231 km	42.1%	241 km	43.9%	59 km	10.7%	18 km	3.3%	0 km	0.0%	549 km
KSHIP Annuity Road – Proposed	0 km	0.0%	0 km	0.0%	2.0%	2.0%	421 km	76.7%	91 km	16.6%	25 km	4.6%	549 km

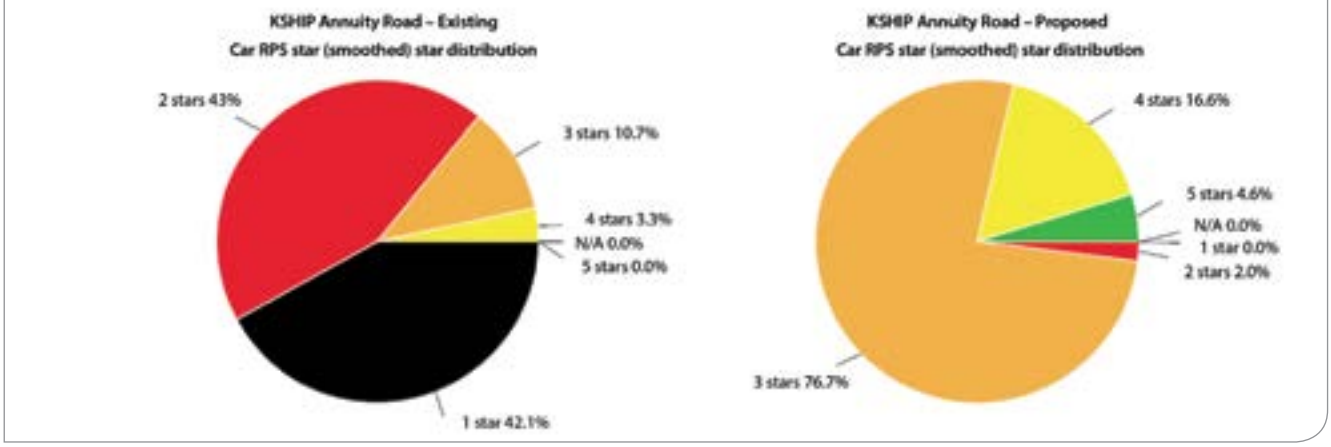

Illustration 3 - Karnataka Design Star Ratings © Make Roads Safe (2013)

The Investing to Save Lives report by the International Automobile Federation Foundation (FIA Foundation, 2016) highlights how an impact investment approach to funding large scale upgrades of roads from one and two-star to three, four and five-star can be achieved. The approach unlocks the savings from health, insurance and long-term care costs into a dividend stream to support the up-front capital investment in safer infrastructure.

MEASURING AND CELEBRATING SUCCESS

The recent launch of the iRAP Malaysia Report by the Minister of Transport highlights how the transparent measurement of road safety interventions provides the base-line and the performance tracking framework to measure road safety improvements and provide the mechanism to measure and celebrate success (MIROS, 2017).

TABLE 2 - THE BUSINESS CASE FOR SAFER ROAD INFRASTRUCTURE (iRAP, 2013)

	World Bank Income Group				
	Low	Lower middle	Upper middle	High	All
Number of countries	33	49	47	49	178
Estimated Facilities Fatalities per year	128,022	494,425	509,299	94,181	1,225,927
Average Fatals / 100,000 population	18.0	19.4	20.9	8.7	18.1
Estimated 10 % of road length (kilometres)	107,582	609,535	992,229	1,545,828	3,255,174
Average Investment Required per kilometre (USD)	100,000	150,000	200,000	400,000	212,500
Potential reduction in killed and serious injuries over 20 years	4,224,726	16,316,025	16,806,867	3,107,973	40,455,591
Economic value of (KSI reduction 20 years (USD billion)	83.2	663.2	2,766.5	2,202.4	5,715
Investment Required (USD billion)	11	91	198	618	919
Investissement annuel nécessaire sur 10 ans (% PIB)	0.3 %	0.2 %	0.1 %	0.1 %	0.2 %
BCR	8	7	14	4	6
Cost per) KSI Saved (USD)	2,546	5,604	11,807	198,950	22,715

At the project or programme level, before and after star rating assessments provide the performance metric for an existing investment and the evidence base for future research and prioritisation. The monitoring of performance should be built in to a project budget and/or coordinated as part of an agency wide research and monitoring program linked to national policy targets. This also provides the opportunity for the design team to celebrate their work and for officials to open or *"ribbon-cut"* new safer four- or five-star roads.

A LOOK TO THE FUTURE

The head of the global health fund addressing AIDS, tuberculosis and malaria stated *"We have a choice: We can invest now or pay forever"*. With road crashes killing on a similar scale and costing 3% of GDP annually, a step change is required in the global response to the road crash epidemic. Annual investments in targeted Safe System improvements must be part of the future (iRAP, 2013).

The Safe System principles accept humans will make mistakes and it is the role of infrastructure, vehicles and speed management to work together to save lives. Road infrastructure will work very closely with vehicle technologies to manage the kinetic energy of potential conflicts. The future is here in terms of driverless vehicles and many of the car to car (collision avoidance, adaptive speed control) and car to road (lane keeping, speed warning) technologies.

The future looks bright and road engineers will play an essential role in leading the transport revolution towards a road system that will be safe for its users. With up to 50 million children and adults injured every year (WHO, 2015) on the world's roads, road infrastructure must provide the foundation for a Safe System and become one of the highest sustainable development priorities for our future.#

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HUMAN FACTORS GUIDELINES FOR A SAFER MAN-ROAD INTERFACE

Technical Committee 3.2.
Design and Operation of Safer Road Infrastructure
World Road Association

WORLD ROAD ASSOCIATION
MONDIALE DE LA ROUTE

Implementation Status of Road Safety Audits and Inspections in Latin American Countries

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STATUS IN LATIN AMERICA


Alberto Mendoza


María Cadengo

Road accidents are regarded as a serious economic and health problem on a global level due to the alarming numbers of deaths and injuries with permanent sequelae associated with them. In fact, around 3,400 people die every day as a result of a road accident. According to the most recent data from the Inter-American Development Bank (IDB), 100,000 people die every year from road accidents in Latin America, making this a particularly serious issue in the region.

Road safety strategies consider various areas in which action can be taken to control and mitigate the problem of road accidents. One such area is the infrastructure, which represents a priority factor for the improvement of road safety. Multiple contributory factors mean that compliance with design and construction standards alone does not always result in safe road infrastructures. Furthermore, once infrastructures are in operation, their safety is not always checked. In view of this situation, an increase has been seen in the number of road safety audits and inspections, which have had excellent results in the countries in which they have been institutionalised. A road safety audit (RSA) is a detailed technical review of safety with regard to the design features of a road infrastructure project. It is required in various project phases (feasibility, preliminary project, definitive project, construction and pre-opening). A road safety inspection (RSI), on the other hand, is a regular and periodic check of the characteristics of an operational road in order to detect defects that require maintenance to be performed for safety reasons. It is important to note that both RSAs and RSIs have to be conducted by qualified and independent technical specialists. In other words, to ensure their objectivity, they cannot be conducted by the people responsible for the infrastructure's design, construction or operation. The preventive nature of RSAs and RSIs makes them the ideal tools for achieving the fundamental objective of saving lives and guaranteeing the safety of all road users, significantly reducing the probability of accidents and the severity of those that do still occur.

In 2016, Technical Committee C.2 *Design and Operations of Safer Road Infrastructure* of the World Road Association invited eight Latin American countries to complete a survey with the aim of collecting information about the use of and experience with road safety audits in the region. Five countries (Argentina, Costa Rica, Chile, Mexico and Uruguay) returned the completed survey, with the responses yielding the following results:

- only Costa Rica has legislation that makes the use of RSAs mandatory. Argentina has a regulation on RSAs but this is not binding in nature and RSAs are only conducted if required by international credit institutions in order for them to grant funds;
- Argentina and Chile are the only countries to have fully developed their own manual on the use of RSAs; Costa Rica is presently in the process of doing so (currently based on the Chilean manual). Mexico follows the recommendations of the Ibero-American Road Institute (IVIA, for its acronym in Spanish) and is also in the process of developing its own manual. Uruguay, on the other hand, intends to adopt the regulations defined in the United Kingdom's manual[1];
- with regard to the decision to conduct an RSA, this generally lies with the authorities responsible for the planning, construction and operation of roads in each country;
- major differences were found between the responses with regard to the professional profile of the auditors, their training and the composition of the audit team. Mexico precisely defines the professional profile that has to be met by auditors, detailing the necessary professional training, accreditation in road safety and years of experience;

1 http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol5/section2/HD1915_May.pdf

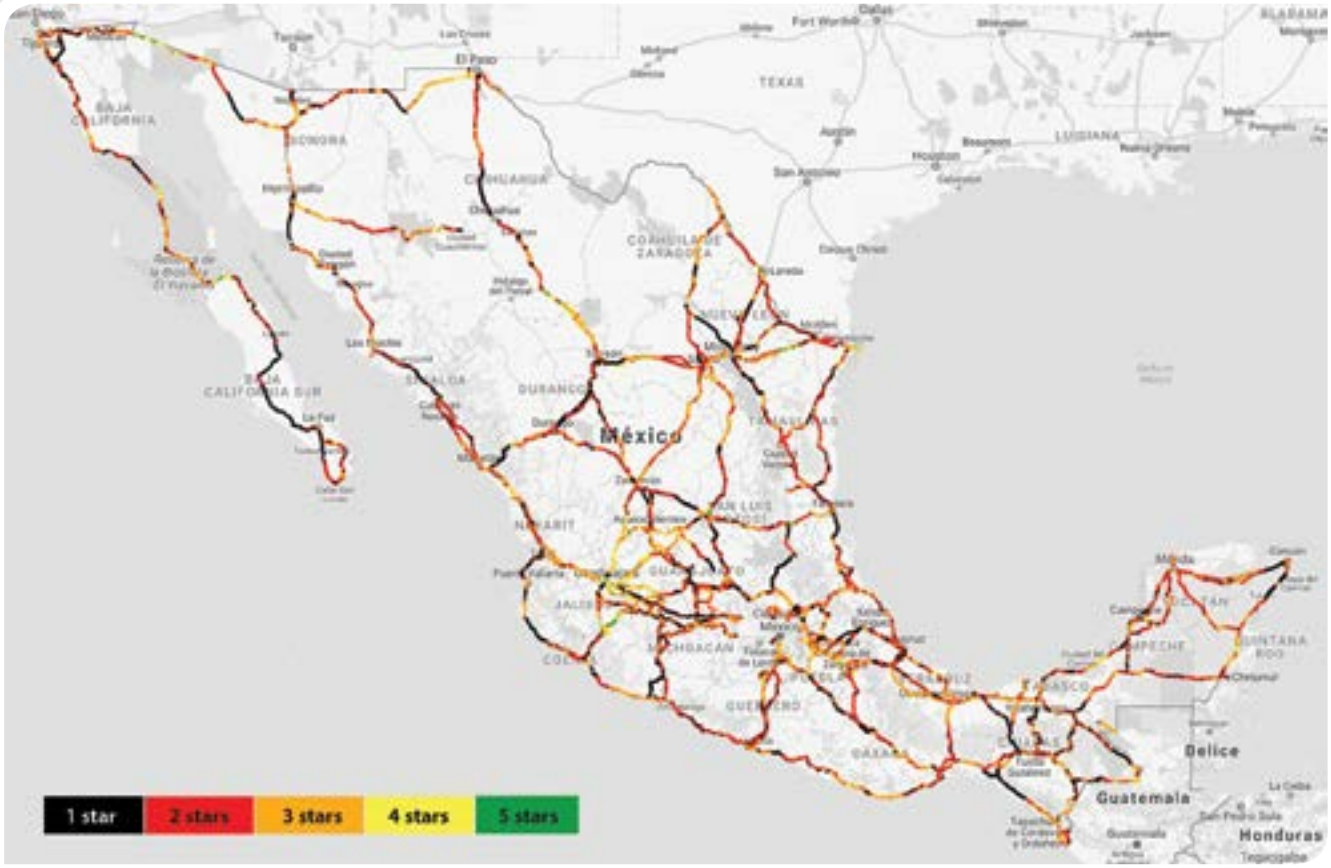

Illustration 1 – iRAP assessment of the federal road network for vehicle passengers, 2012

- the competent authorities are responsible for deciding which recommendations derived from the RSAs are adopted;
- the countries surveyed have generally had pilot experiences of audits on existing roads (RSIs); Costa Rica is the only country to report working on an RSA in the construction phase, while one could have been conducted during the project phase in Argentina.

EXPERIENCES IN MEXICO

In addition to working on the creation of a Road Safety Audit Manual, the following experience has been gained in Mexico with regard to the performance of audits based on the procedures and recommendations established by the World Road Association:

- inspections of roads in operation have been conducted for several years now using conventional methods involving checklists. These have been used to inspect the road safety of the 16,000 kilometres of key trunk roads in the country;
- the safety of 46,000 kilometres of federal roads was assessed using the iRAP method in 2012 and 19,000 additional kilometres of state jurisdiction (secondary roads) were assessed in 2013. This method involves an inspection vehicle (Hawkeye 2000) driving along the roads and generating images every 10 metres. The information recorded is then used by office-based staff to classify the road characteristics based on over 60 variables and estimate the infrastructure risk for each 100-metre section on a scale of 1 to 5 stars, with 5 corresponding to the best safety conditions and 1 to the worst. The method considers four types of users: vehicle passengers, pedestrians, cyclists and motorcyclists. It furthermore proposes a series of improvement measures assessed on the basis of their cost-benefit ratio. *Illustration 1* shows the 2012 assessment of the federal road network with regard to vehicle passengers. It indicates that 3 and 8% of the roads were classified as having the best safety standards (5 and 4 stars respectively), while 35% received 3 stars, 30% 2 stars and 23% 1 star. The improvement measures derived from this assessment make it possible to implement an investment programme for safer roads in the short, medium and long term in line with the available resources;
- the health sector has promoted the performance of road safety inspections for urban and suburban roads in the country's main cities;
- by inspecting several road sections, the Mexican Institute of Transportation (IMT, for its acronym in Spanish) has been developing a method that combines: (I) existing documentary information about the relevant road section, (II) the reconstruction of the section's geometry and (III) data collected during field trips and through the recording of images and videos:
  * the first type of information relates to operational data such as censuses detailing vehicle classifications; location, frequency and type of collisions; speeds;

pavement condition; geo-demographic environment; data from the road's physical inventory (e.g. longitude, roadway width, number of lanes, road markings); etc. All of this information is georeferenced and managed in a geographic information system,

* the second type of information has been obtained by LiDAR flights over the relevant road section. These make it possible to reconstruct the mapping and geometry of the section as well as to analyse it against the geometric design standards and RSA recommendations using specially developed computer programs. As a result, it is possible to identify risks and devise improvement measures. This information is also georeferenced. As the improvements arising from this analysis are generally of a considerable scale and cost (e.g. corrections to the horizontal alignment, bends, superelevations, cross sections, intersections, drainage, etc.), they tend to be conducted over the medium and long term,
* the third type of information has been generated using Hawkeye 2000 equipment and can be used to obtain a sequence of images of the relevant section in both directions. The office-based analysis of the images makes it possible to identify infrastructure-related risks (e.g. deficiencies with regard to road markings, cross sections, barriers, off-carriageway areas, access controls, the central reserve, visibility distances, slip roads, public transport facilities, pedestrians, etc.) and propose suitable improvements. This information is also georeferenced. The measures derived from this analysis are generally low in cost but of high impact and can therefore be quickly incorporated into routine and periodic maintenance programmes.

It should be noted that the evidence of risk can arise from one, two or all three of the aforementioned types of information. As a result, the proposed

Illustration 2 – Risk and proposed improvement based on geometric restitution

Illustration 3 – Determination of the level of risk based on images

improvement measures are sometimes primarily based on one type of information but always confirmed and complemented by the other types. By way of example, *illustration 2* shows the use of the second type of information to identify a site where work is required to a footbridge or pedestrian bridge, extending it over a ramp that it does not currently reach (yellow dotted line), posing a risk to pedestrians who have to cross at road level and by traversing slopes. This measure is based on the third type of information, as shown in *illustration 3*, coupled with the information on collisions (first type of information).

CONCLUSION

Road safety audits and inspections are extremely useful tools for assessing the safety of the road infrastructure and therefore being able to channel economic investment as efficiently as possible, a matter of particular importance in Latin American countries, which have limited resources in this regard.#

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Pedestrian Audits – A Checklist for Safety and Quality Inspections of Pedestrian Infrastructure

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Illustration © SVPT


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The worldwide number of deadly road traffic accidents is in a critical range with 1.25 million incidents in 2013. In addition, it is particularly in low and middle-income countries (LMIC) that the motorization rate and thus the number of road traffic accidents will continue to increase (WHO 2015). It is to be assumed that a large part of road traffic accidents is also due to an insufficient foot traffic infrastructure. In addition, it can be assumed that the proportion of pedestrians will continue to increase.

Therefore, there is an urgent need for action to improve the pedestrian infrastructure in the future in a qualitative and secure manner, in order to meet the demand for qualitative pedestrian infrastructure, as well as to increase pedestrian safety.

For this purpose, the Walkability Checklist as well as the Checklist for Quality and Safety Inspections of Pedestrian Infrastructure (CQSI) described below were developed.

The Walkability Checklist as well as the CQSI were developed within the action point 358 of the European Cooperation on Science and Technology (COST). COST enables researchers to set up their research network in Europe and beyond, and the action point 358 is dealing with the Pedestrian Quality Needs. One task of COST 358 with regard to the formulation of the intended state of the pedestrian quality system is to assess what is required to satisfy the pedestrians needs and wants, relative to their importance, tasks to be performed, competences and abilities. The requirements also refer to the opportunities the pedestrians have to satisfy their needs.

This project was not intended to look for applications of certain designs, facilities or services, but to find the optimal solutions to facilitate walking and sojourning.

A basic principle in this regard is that needs and wants of pedestrians can only be satisfied if different requirements are met. Following Rumar's ideas on the orders of problems (Rumar, 2002), three orders of requirements are distinguished:

- *first order requirements*
  These are visible, tangible, concrete requirements with regard to the equipment for pedestrians, contact options of the social environment, design and equipment of public space and the availability, design and equipment of the transportation system. These requirement specifications concern pedestrians, vehicles, the physical environments and elementary operational behaviour of other people (including other road users) in the environment as well as concrete opportunities for pedestrians to perform intended activities. Examples of first order requirements are thus: speed limiting measures, pedestrian crossings, conditions of surface, other designs of roadside elements and also the equipment of roadside elements;

- *second order requirements*
  These requirements are derived from first order requirements and relate to tactical level facilities and services, like network characteristics, traffic rules and enforcement, vehicle regulation and traffic management. These criteria describe the traffic flow. Examples of second order requirements are thus: public transport (relevance and schedule), speed limits, traffic lights, etc.;

- *third order requirements*
  Requirements of this order are preconditions for second and first order requirements. They form the fundament to make sure that the first and second order requirements can be met. These third order requirements concern land use characteristics, modal split, pedestrian quality culture, competences, abilities, education, training, adequate organisational structures, data availability, research and development, strategic planning, etc. They contain particularly aspects related to the quality and the atmosphere of walking, such as the proper function (connection or sojourn), the feeling of safety or the modal split.

The orders of requirements developed by Rumar were considered while developing the

Walkability Checklist as well as the Checklist for Quality and Safety Inspections of Pedestrian Infrastructure (CQSI) which allow, among others, the detection of quality and safety deficiencies of the pedestrian infrastructure.

WALKABILITY-CHECKLIST

As already described, the structure of orders of requirements was carried over to the structure of the Walkability Checklist stated below. It concerns aspects of the design of roadside environment as first order requirements, traffic rules and traffic flow as second order requirements and aspects of road user behaviour as third order requirements.

With regard to specifying requirements, not only demands regarding objects, facilities and services matter, but also requirements regarding context, process and procedure need to be specified. Process and procedure requirements relate to the following questions: *'who is needed to get things done' and 'what procedures apply to provide adequate opportunities for intended pedestrian behaviour'.*

The Walkability-Checklist provides a first overview on the pedestrian qualities and it checks whether general requirements are fulfilled. The further aim of this Walkability-Checklist is to clarify which stakeholder is responsible for the different aspects that have to be considered and which procedures need to be applied.

Since the checklist only provides a first overview on the pedestrian qualities, the CQSI was developed with which it is possible to detect all potential deficiencies of the pedestrian infrastructure in detail.

PEDESTRIAN QUALITY NEEDS (PQN) INSPECTION PROCESS AND THE CHECKLIST FOR QUALITY AND SAFETY INSPECTIONS OF PEDESTRIAN INFRASTRUCTURE (CQSI)

A Pedestrian Quality Needs Inspection (PQN Inspection) conducted by experts, is a systematic on-site review of the existing situation concerning the fulfilment of requirements to identify hazardous conditions, faults and deficiencies that may lead to less pedestrian demand, worse pedestrian conditions or serious accidents. Referring to the Directive 2008/96/EC of the European Parliament and the Council on road infrastructure, safety management inspections are surveys on the existing infrastructure in operation, whereas audits are related to planned infrastructure projects. Taking this into account the PQN-Inspection is an inspection from the view of pedestrians. On the other hand, the instrument could also be used for planned projects too. In this case it is better to use the expression *"PQN Audit"*.

The PQN-Inspection, with the following characteristics, could also be used as a management tool of an overall quality management process:

- it is systematic – this means it is comprehensive and carried out in a methodical way;
- it needs to be carried out by an independent person or team with experience in safety and security work, traffic engineering, pedestrians' behaviour and/or road design;
- it relates to an existing situation. That could be a city, an area or even only a road. This instrument could also be used for planned projects too;
- it is pro-active, trying to increase the quality of the pedestrian environment and to prevent accidents and incidents by recommending corresponding countermeasures based on the identification of possible quality, safety and security deficiencies.

Furthermore, the PQN Inspection Process is divided into four steps:

Step 1 Preparatory work in the office
Step 2 On site field study
Step 3 PQN Inspection Report
Step 4 Remedial measures and follow up.

In general, the whole PQN Inspection is based on the detection of quality and safety deficiencies of pedestrian infrastructure. For this reason, the CQSI was developed for the usage in the second step of the PQN Inspection Process. This checklist allows the detection of all relevant deficiencies of the pedestrian infrastructure.

The CQSI is based on developments of Road Safety Inspections and Audits. For example, the PIARC Road Safety Audit and Road Safety Inspections Guidelines were considered and questions concerning pedestrians were largely adopted (PIARC, 2011 / PIARC 2012). Additionally, important questions from different sources of literature and own considerations were inserted.

At the moment the checklist includes about 300 questions about the aspects which are based on the orders of requirements of Rumar. The checklist is focusing on the

TABLE 1 - ASPECTS WHICH ARE COVERED BY THE CHECKLIST FOR QUALITY AND SAFETY INSPECTIONS OF PEDESTRIAN INFRASTRUCTURE (CQSI)

Design and equipment of roadside environment (1st order requirements)	1. Function 2. Sidewalks, Walkways and Walking Paths 3. Cross section 4. Intersections 5. Public and private services 6. Parking 7. Public transport stops 8. Pedestrian Crossings 9. Signing, Marking, Lighting 10. Plantations 11. Barrier free design
Traffic flow (2nd order requirements)	1. Speed and Traffic Volumes 2. Public Transport 3. Traffic Lights
Quality and climate of walking (3rd order requirements)	1. Security 2. General Climate, behaviour and performance 3. Pedestrian Policy and Strategy 4. Walking friendly environment

following aspects which are listed in *table 1*.
For example, a question from this checklist is the following: *"Is two-way visual contact ensured between pedestrians and motorists in sufficient stopping distances?".*

Illustration 1 shows a situation from a mid-size town in Germany. The visual contact between motorists and pedestrians at this pedestrian crossing is not ensured because of parking cars. There is therefore the risk that accidents with pedestrians can occur, since these are not seen in time. A countermeasure would be to prevent the parking or any obstacle which is reducing the visibility of pedestrians in front of a pedestrian crossing, so that the visual contact between pedestrians and motorists is ensured.

Illustration 1 - Insufficient two-way visual contact between pedestrians and motorists

As shown, the general goal of the CQSI is to state out detailed deficiencies, which are related to the whole system of the quality and safety of walking. In addition to existing inspection and audit instruments, this checklist allows the detection of many other aspects especially in terms of the traffic flow and the quality and atmosphere of walking. The quality and atmosphere of walking are related to the design of the pedestrian infrastructure and whether this design corresponds the requirements of pedestrians. For example, this could be a walkway which is wide enough for attractive and safe walking (walking friendly environment).

The checklist is quite detailed and consequently, during an inspection, a systematic collection of the deficiencies found should be done. With all the listed questions in the checklist, however, there is the possibility to detect almost all potential deficiencies of the analysed area or road section.

The CQSI is usable for road sections, squares, shopping areas as well as residential zones or whole districts. For using the checklist, it has to be clarified, if the inspection is involving small sections of the road with repeated checklists or several runs along the whole road or an area using one single checklist. Using one or more checklists depends on the chosen length of the road or the size of the area and also on their complexity. In order to be able to assign the detected problems to the road section or the area in retrospect, it is necessary to insert the exact location, house numbers, street corners, GPS coordinates, etc. to the deficiencies.

In the end the completed checklists have to be transferred into investigation forms. For each of the most serious deficiencies, a specific recommendation for countermeasures should be worked out.

FURTHER STEPS AND CONCLUSIONS

There is currently a further revision of the developed CQSI. One step to be developed, is the further consideration of the requirements of reduced mobility persons and therefore the barrier free design.

The use of this Checklist for Quality and Safety Inspections as a part of the PQN Inspection Process is not only limited to high income countries. We strongly recommend to apply the checklist also in in low and middle income countries to detect potential deficiencies, since, in addition to faulty or non-existent infrastructure, one of the main hazards of dying in these countries are road accidents (WHO 2015).

Precondition for the inspection with the aim if the CQSI and the development of specific countermeasures is the use of experts with the needed experience. Furthermore, the implementation of the countermeasures depends on financial resources of the municipality. But with implementing countermeasures for the detected deficiencies there is the possibility to invest in pedestrian infrastructure with a high standard of safety and quality for pedestrians.

In addition, it is important, to decide whether the CQSI can be implemented in the Road Safety Manual of PIARC. By implementing this new instrument, an improvement of the safety for pedestrians and a new design of roads with high qualities for walking are expected.#

Prioritizing Road Safety Actions in an Effort to Save Lives

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Laurent Carnis

Considering that the objective of road safety policy centers on reducing road-based mortality and morbidity rates, policy success is contingent upon mobilizing both human and material resources. These resources remain relatively scarce, and authorities are required to make some hard choices. Not all projects can be backed by governments or agencies assigned to oversee road safety. This hurdle to action affects all countries, regardless of their level of economic development. Low and middle income countries are especially prone to such challenges, given their very limited resource availability and higher rates of mortality and morbidity (WHO, 2015). Prioritizing safety-oriented actions offers a strategic approach to obtaining satisfactory results in the area of road safety.

WHAT ARE THE KEY CHALLENGES INVOLVED IN THIS PRIORITIZATION EFFORT?

Some of the challenges are ***ethical***. The goal calls for saving the greatest number of lives and reducing total morbidity within the constraints of available resources. The strategy thus consists of implementing a policy that yields a series of well-tailored measures producing the most beneficial effect possible. Otherwise, lives that could have been spared will be lost, and injuries that could have been avoided will cause victims.

Other challenges remain in the ***economic realm***. Any action undertaken engenders what economists call an opportunity cost, in reference to what is renounced when a given course of action is initiated. For example, the decision to launch a communication campaign entails deploying resources that are then no longer available to conduct infrastructure audit missions. Improving a particular urban intersection implies foregoing other improvement projects aimed at protecting pedestrians elsewhere. The focus lies in making optimal use of the resources at hand and selecting the most effective measure.

Moreover, this prioritization exercise includes a ***political dimension***. The authorities are tasked with pursuing a credible policy, whose premise actually translates into safer roads and whose protocols are inherently efficient and acceptable to all stakeholders. Prioritizing also seeks to discard ill-advised solutions along with mostly ineffectual responses. What purpose is being served to mobilize resources or impose constraints on users if anticipated results are not being achieved?

SO WHY SHOULD AUTHORITIES PRIORITIZE?

The main reason concerns the existence of ***resource constraints***. Specifically, the higher the level of resources available, the more relaxed the pressures placed on prioritization steps. The number of measures capable of being financed would rise as a consequence. Yet other reasons can also lead decision-makers to prioritize road safety measures.

The decision-maker must strike a balance within a «***portfolio of potential responses***». Such a strategy may favor the field of education, training or police monitoring, or it may emphasize road infrastructure campaigns. From an infrastructure standpoint, action plans tend to target specific approaches (e.g. road signs/markings, structural modifications, new construction, improvement programs, quality and safety control) and distinct geographic preferences (motorways, urban settings, rural road connections).

Given that not all action plans produce the same outcomes (varying mortality and morbidity reduction rates) and impacts diverge depending on the metric (fatalities, serious injuries, intended user categories, etc.), a ranking of priorities thus becomes necessary.

Beyond the differentiated impacts resulting from such measures, a distinction must be drawn in terms of their relative costs. These measures impose a financial burden not just by their unit price, but also by the total project cost. Upgrading horizontal road signs does not require the same level of investment as, say, improving a mountain road (with both unit and total costs amounting to far less for a signage project). Similarly, introducing a bicycle path into a city layout is likely to be less expensive than instituting

a road sign maintenance policy throughout the network (lower unit costs, yet higher total costs for the bicycle path project).

The mandatory nature of a prioritization procedure can also be explained by the *coexistence of different time scales* across the various projects undertaken. As such, the cost breakdown of measures and their associated impacts span different time frames. A temporal comparison would necessitate discounting the values used to determine a return (i.e. monetizing the resources deployed in comparison with the resulting monetized benefits). Project scheduling must also overlap with the decision-maker's timing imperatives, which take into account both administrative (budgetary processes) and electoral timetables (term limits imposed on elected officials) (Fridstrom and Elvik, 1997).

PRIORITIZATION: A COMPLEX, MULTIFACETED ACTIVITY

Prioritizing remains a complex activity, in recognizing that the motivations influencing decision-makers to take action are multiple and multifaceted, while the objectives are not necessarily uniform. This complexity also results from the needs of political leaders to control knowledge regarding the relations between objectives, resources and results, as depicted in the ***performance triangle*** *(illustration 1)*.

Once the decision-maker has mobilized the resources necessary to take action (namely budget allocations to finance road safety production factors), three critical relations must be established in order to ensure effective policy intervention, i.e. ability to achieve the anticipated objectives.

An initial relationship can be drawn between means and objectives. The approach thus entails selecting a suitable action plan for meeting the challenge and assessing the ***relevance*** of the response provided. Should infrastructure be modified in order to reduce traffic speeds whereas in reality the spike in accidents is due to another factor, then the measure will not produce its desired effects. The correct accident risk factor must be identified and the appropriate countermeasure implemented.

A second relationship involves results and objectives. The challenge here is one of ***efficacy***. In returning to the example cited above, should the abnormally high accident rate observed be attributed to excessive speeds, then the appropriate countermeasure resulting in a durable effect might not be random speed checks, but instead infrastructure alterations that seek to prevent driving over the speed limit (speed bumps, traffic calming, etc.).

The third relationship is about ***efficiency*** and consists of comparing means with results. The challenge for

Illustration 1 - The performance triangle

the decision-maker here is to appropriately apportion its response given the stakes at hand. As an example, attention might be focused on determining the optimal number of speed bumps.

Relevance, efficacy and efficiency are thus three requirements facing the decision-maker within the scope of prioritizing action campaigns. All three assume the decision-maker is in possession of fine-grained information on key parameters (accident risk factors) and on the effects of countermeasures, along with the procedures for in situ application and implementation. In this vein, introducing a system for collecting and analyzing statistics that are tracked, reliable and detailed, as well as operational research results, proves to be fundamental.

The decision-maker also needs to tackle other challenges related to policy decisions. A road action campaign does not necessarily yield its promised effects yet, on the other hand, may produce unexpected, or even undesirable, impacts. These ***compositional effects*** can take on various forms, including extra driving time, added traffic congestion and perhaps bottlenecks. The action might lead to: redistributing the risk between user categories (a feeling of enhanced safety by adopting a particular measure might make other users not targeted by the initial measure more vulnerable), impacting the environment (a safer road alignment will infringe upon protected animal habitat or plant life), or modifying infrastructure accessibility conditions for certain user categories.

Another challenge pertains to the ***behavioral reactions*** of the users targeted by the given measure, which may be technically effective but not acceptable from a social or political perspective (Rose, 1993, p. 46). The measure may be perceived as interfering in private life (e.g. case of photo radar devices identifying the driver). As a consequence, the search for effective road safety measures must acknowledge the objectives of social justice and fairness. Users demonstrate ***learning capacities*** (identification of speed check points, changes in driving behavior when the

road network is better maintained) while also ***cognitive limitations*** (poor installation of children's seats, improperly fastened helmets, etc.). These behavioral changes, which lie beyond decision-maker control, highlight both the care required when choosing measures and the need for outreach to the general public.

Operational implementation could provide a source of obstacles given the presence of multiple constraints: technical (e.g. maintenance of control devices), legal (compliance with penal and administrative procedures), functional (budgetary constraints, Ministerial assignments, agency organization), and those tied to human resources (qualified personnel, road safety training capacities). These operational barriers may be lifted by solid efforts focusing on precise and comprehensive operational planning, making it possible to identify constraints ahead of time, lay out action plans and determine the objectives associated with intervention.

Moreover, a family of constraints is tied to the ***production of public policy***. The measures enacted impose that organizations overseeing road safety policy assume responsibility for ultimate implementation. In short, these measures are to go hand in hand with mainly cooperative organizations, which have their own objectives and procedures to satisfy and, consequently, may not be in favor of the new measures (Nishimura, 2017). On occasion, measures are subjected to both intra- and inter-agency rivalries, in which case strategic planning serves to define the assignments of the various organizations, their objectives and their commitments, as well as the protocols adopted for purposes of cooperation and exchange.

SOME OF THE INGREDIENTS REQUIRED FOR SUCCESSFUL PRIORITIZATION

The importance of information and knowledge

Strong knowledge of the stakes at hand proves to be essential in the decision-maker's ability to prioritize actions in a *rational manner*. Accordingly, the prioritization step is less about ordering priorities relative to the various actions than about deriving an order of priorities that matches the reality of these stakes. To accomplish this step, it is necessary to produce and collect high-quality statistical data on a systematic basis. The creation of a road safety observatory or specialized statistics office appears to be critical in this pursuit. The reliability of measures helps to accurately and consistently evaluate the challenges and their effects, while the durability of measures allows for comparisons over time and an observation of relevant trends. The information required comprises accident risk exposure and mobility as they pertain to behavior and infrastructure.

Familiarity with the impacts of countermeasures

The challenges encountered also address the knowledge of effects associated with potential countermeasures. The focus here is to compile collections of best practices and solutions to identified problems, in addition to deploying and generating functions that reduce accident risks. Scientific literature, expert appraisals, drafting of guides and manuals, like those sponsored by the World Road Association, all constitute valuable resources for decision-makers seeking to clarify these causality relationships.

Basic economic considerations

Prioritizing action campaigns implies the ability to compare the underlying actions. For such comparisons, the benefits and costs of each measure must be estimated as well as monetized. The ensuing economic calculation requires, among other things, ascribing a value to intangibles (e.g. human life) and incorporating a discount rate in order to compare income flows over time. Prioritizing also implies that the decision-maker has adopted a transparent procedure for basing decisions (net discounted value, cost-benefit ratio, etc.).

The prioritization objective must serve to identify and select appropriate countermeasures for reducing road mortality and morbidity, in addition to ensuring that the measures do not produce undesirable effects, remain efficient and maximize the social benefit.#

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Road safety issues in Latin America

An interview by Laurent Carnis with Hilda Gómez

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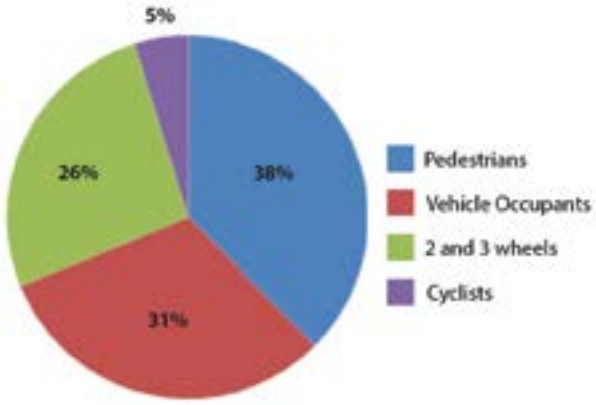
Associate member of Technical Committee C.1 *National Road Safety Policies and Programs* of the World Road Association
Illustrations © Author


Hilda Gómez

Laurent Carnis: Road safety is a crucial issue worldwide as it can save many lives. It is a particularly important matter in low and middle-income countries. What is the present situation in Latin America? What trend has been evident over the last decade?

Hilda Gomez: According to information from the WHO and the Ibero-American Road Safety Observatory (OISEVI) around 115,000 people die on the roads and streets of Latin America every year.

More than 67% of the deceased are classed as vulnerable users (pedestrians, cyclists and motorcyclists).



It is estimated that about 65% of deaths occur in urban areas, although there are few statistics at urban level.

Developments in recent years show that the total number of victims has remained more or less constant; the figures are falling in some countries but rising in others, as seen in the following graph:

What are the main approaches being taken by South American countries to substantially improve road safety?

Latin America has made continued progress with regard to the position of road safety. The most important actions that have been developed include the following:

1. the creation of national agencies responsible for road safety;
2. improvements to legislation relating to road safety;
3. the creation of road safety plans;
4. awareness campaigns; and
5. observational studies of risk factors.

The main cause of accidents in the region is considered to be the human factor. However, it is also known that there is under-reporting of vehicle and infrastructure-related

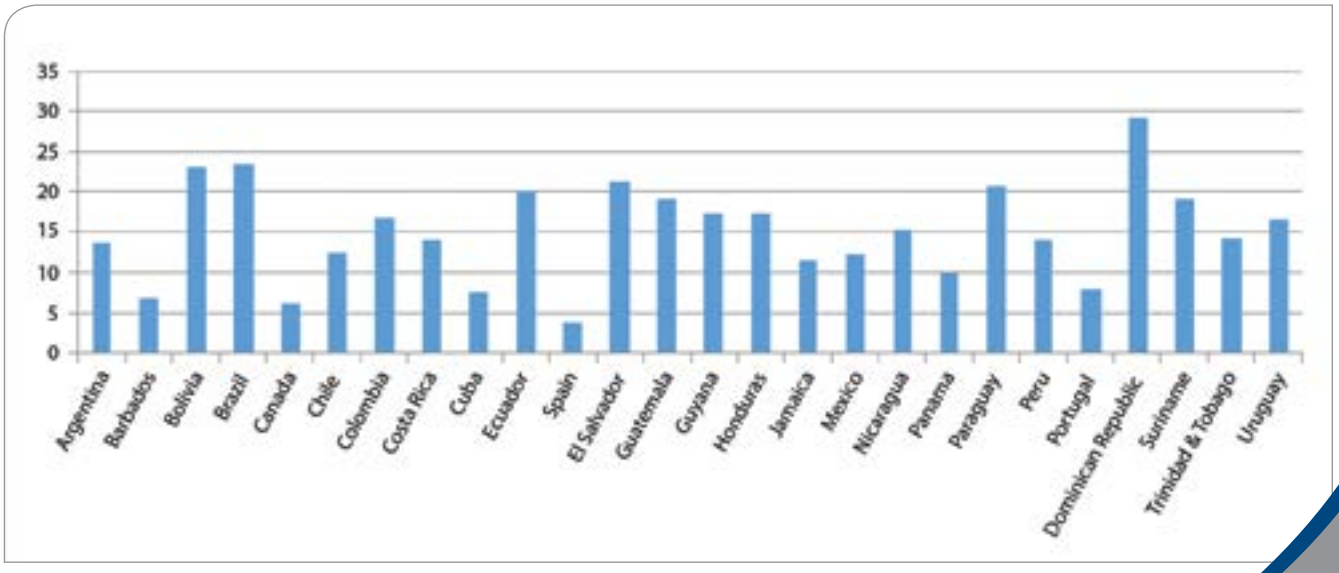
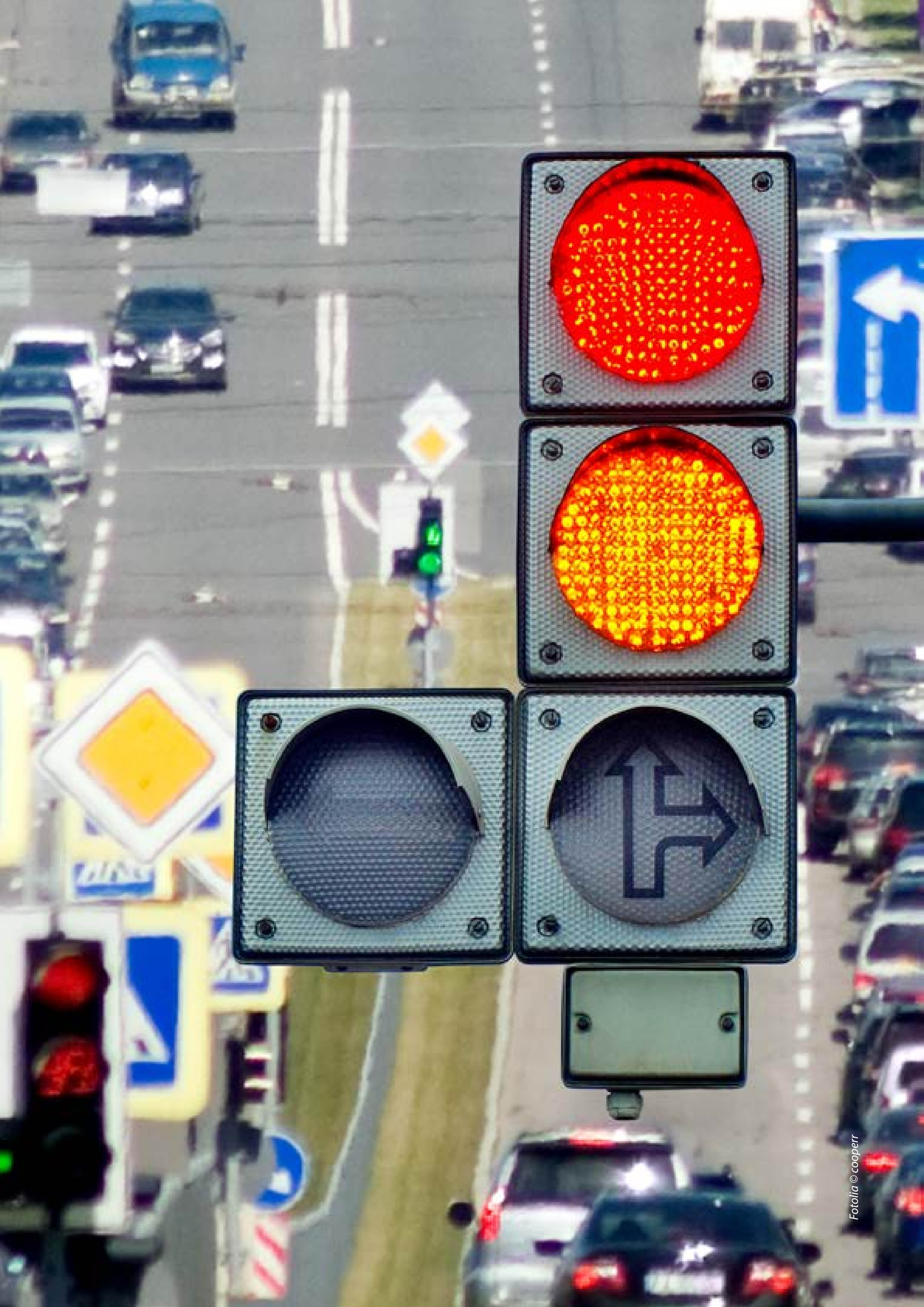


Illustration 1 – Fatalities per 100,000 inhabitants. Source: WHO Global Status Report on Road Safety (2015)



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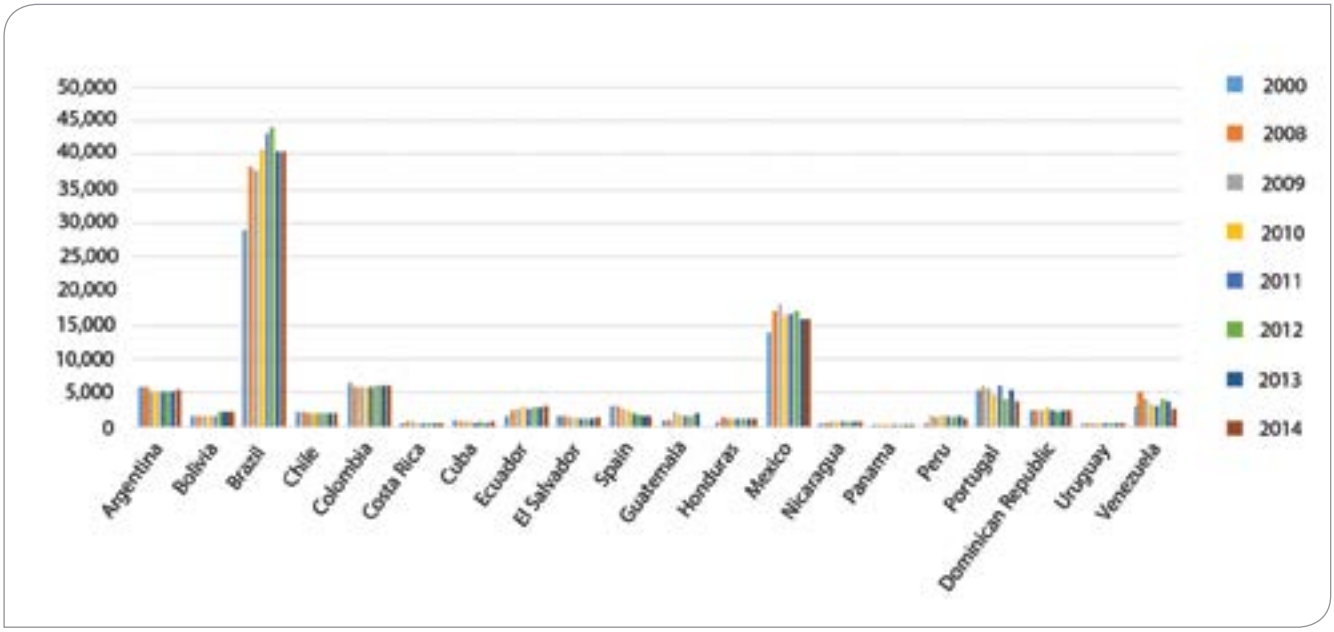

Illustration 2 – Deaths in Latin America 2000 – 2014 © Ibero-American Road Safety Observatory (OISEVI, for its acronym in Spanish)

causes. It is necessary to highlight that low standards exist with regard to the requirements and processes to be met/completed when issuing driving licences, as well as with regard to the training of drivers and, even more so, motorcyclists. Road audits and controls are in need of great improvement.

The importance of checking the safety of vulnerable road users should be heightened when designing infrastructures as well as during road controls and road operation. Although pedestrians are still the main victims, the high growth in the number of motorcycles is leading to rising motorcyclist deaths – the numbers of which now exceed those of pedestrians in many countries. This situation requires special measures as motorcycles have become a family vehicle, transporting children of all ages, with high risks.

What are the main interventions which could be efficiently implemented to improve the current situation and save the maximum number of lives?

A suitable road safety policy focused on the main causes of road accidents with coordinated campaigns and controls could rapidly prevent many deaths. The countries need government policies on road safety and should collate quality data so as to identify the causes of accidents.

The identification and improvement of sites at which high numbers of accidents occur is one measure that can rapidly improve road safety.

It is important to incorporate road safety into the planning, control and operation of mobility plans in urban areas, with emphasis on vulnerable road users, promoting 30 kph zones and changing speed limits to 50 kph. Road safety plans for the cities would help. Increasing the number of speed checks on urban roads would reduce the severity of accidents.

It is necessary to improve driver training as well as the requirements and tests for obtaining a driving license, both for individuals and for professional drivers. This should involve practical exams to test their skills. It is also necessary to transform the general mindset that exists in our countries and has inevitably resulted in the risky behaviour previously seen being associated with social approval and a reaffirmation of masculinity; it is for good reason that 81% of the people killed on the roads in Latin America each year are male.

Companies should be involved in road safety through corporate road safety plans. This will help to raise awareness of what constitutes appropriate road behaviour, making employers responsible for the safety of their employees during journeys.

Are there any disparities between South American countries with regard to the road safety situation?

One of the indicators that can help to answer this question is the rate of deaths per 100,000 inhabitants presented by the Pan American Health Organization (PAHO) in its annual report 'Road safety in the Americas' (2016). Whereas in countries such as Cuba, the rate is less than 10 deaths per 100,000 inhabitants, in others such as Bolivia, Brazil, Belize and the Dominican Republic, the rate is more than 25 deaths per 100,000 inhabitants.

What actions is CAF currently taking to help South American countries improve the road safety situation?

Over the last decade, CAF has committed more than USD 2.5 million to improving road safety

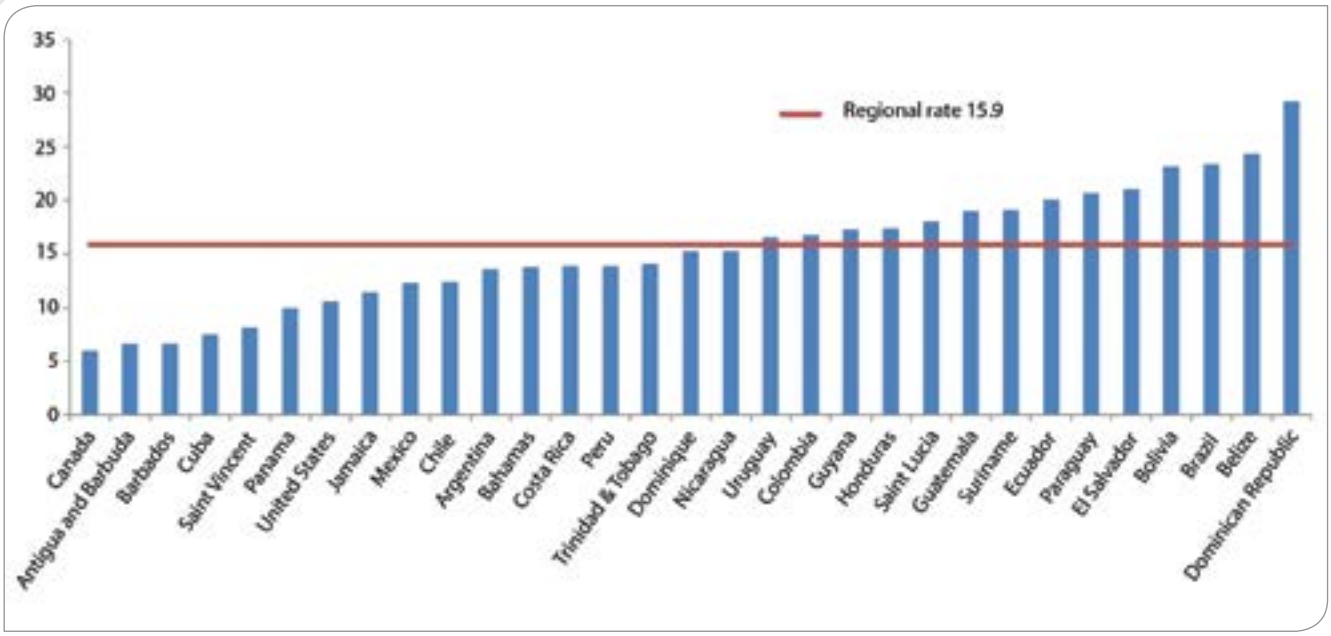

Illustration 3 – Death rate per 100,000 inhabitants

in the region through the exchange of experiences, the visibility of public policies and the development of road safety plans for vulnerable users, among other initiatives.

The aspect of road safety has been included in most of the urban mobility plans developed by CAF for the region and the development of road safety audits has been integrated into both highway-related credit projects and large-scale urban projects such as the Lima and Panama Metros.

Another matter in relation to which CAF has had an important impact is that of motorcyclist safety. Motorcyclists are the most vulnerable road users (facing 20 times the risk of a car user and double the risk of a pedestrian) and the group with the fastest growing accident figures. In this regard, CAF has promoted and provided guidance on the creation of comprehensive motorcyclist safety plans in Costa Rica, Buenos Aires and Bogotá, and is currently creating such plans in Corrientes, Resistencia and six municipalities in the metropolitan area of Buenos Aires.

Furthermore, since 2015, CAF has led the road safety initiative of the multilateral development banks as well as the aim of safety in the SuM4All initiative (sustainable mobility for all). It also sits on the committee of experts of the FIA's high-level panel for road safety as well as on the advisory committee of the Ibero-American Road Safety Observatory (OISEVI) and the World Road Association's road safety committees.

CAF is currently initiating a regional road safety program which aims to promote road safety in both transport companies and other companies whose activities include transportation. At the same time, it is initiating the development of a good practice manual for road controls by transit police.

CAF has made the following publications on road safety:

- Motorcycle and road safety for a safer coexistence (memories)
- *Metodología para elaborar planes de seguridad vial para motociclistas* - Methodology for creating road safety plans for motorcyclists
- Ibero American comprehensive guide for traffic crash victims
- *La motocicleta en América Latina: caracterización de su uso e impactos en la movilidad en cinco ciudades de la región* - The motorcycle in Latin America: a look at its use and how it is impacting mobility in five cities in the region
- Road safety guidelines
- Upscaling Support and Developing A Shared Approach 2011 - 2015
- *Estudio sobre las condiciones del traslado de niños en motocicletas en América Latina* - Study on the conditions for transporting children on motorcycles in Latin America
- *Guía de Experiencias internaciones para seguridad de motociclistas* - Book of international experiences for motorcyclist safety

What are the main obstacles that South American countries face when improving the current road safety situation?

I believe that the region needs to raise greater awareness of the magnitude of the consequences of road accidents in terms of loss of life and serious injuries that leave people with disabilities so as to position road safety as a state policy. Many countries talk about road safety but are not prioritising the actions required. In addition, citizens are unaware of the figures and that so-called 'traffic accidents' are preventable; they continue to believe that they are an inevitable consequence of transportation. They are not a public policy priority and citizens do not demand that they are.

Some countries still do not have a single authority in charge of road safety with autonomy and its own resources to implement actions. There is also a lack of coordination between the various entities involved in road safety at national and local level (national authority, local governments, transit police, etc.). This is primarily due to the duties of each of these entities being insufficiently defined or in some cases being transferred to other entities. Few cities have identified road safety as a fundamental part of their mobility plans. They continue to prioritise speed over safety despite the fact that the majority of deaths and injuries occur in urban areas.

South America is a large continent with dynamic people and a common language. Are there any cases of cooperation with the aim of promoting road safety? Are joint actions being taken? What actions could be implemented across the continent as a whole?

One of the best examples of cooperation with regard to road safety in Latin American is the Ibero-American Road Safety Observatory (OISEVI). This is an international cooperation organisation made up of the highest road safety authorities from the Ibero-American member countries. The Observatory was created in 2010 and meets annually to share experiences and data on the situation in each country.

Another interesting example of cooperation is the Ibero-American Federation of Road Violence Victims' Associations (FICVI), which brings together civil society organisations of victims and other persons affected by road accidents in Latin America. This civil society initiative has made it possible to position road safety as a matter of national importance, empowering and giving more visibility to the victims of road accidents. In particular, CAF has worked with the FICVI to develop the Ibero American comprehensive guide for traffic crash victims , which is expected to help develop the victim support units in the region.

It would be of great help to have an independent and technical organisation that could analyse the road safety situation in the region and make suggestions about priorities there.

The World Road Association recently published and made available a new version of the Road Safety Manual. Is this an important and valuable resource for taking appropriate decisions in Latin America?

I believe that the World Road Association Road Safety Manual is an excellent aid for Latin American countries as it gives professionals up-to-date information about road safety in general, including information that is often not taken into account, and details principles for road safety management. This is a burgeoning topic in the region and needs to be promoted. The Manual is very important in this regard. Once a Spanish version is available, it will be easier to use.#

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Vulnerable Road Users on Rural Highways: A South African Perspective

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Illustrations © Author


Steven Robertson

Available publications, guidelines and manuals on road safety tend to relate to Vulnerable Road Users in the context of high income or developed countries (HICs).

However, the factors affecting road safety in low and middle-income countries (LMICs) does not always align with the experience in HICs. These factors may include the standard of road infrastructure, general maintenance practices, availability of different transport modes, law enforcement and general road user behaviour.

This article highlights road safety challenges from a South African perspective, with a specific focus on vulnerable road users.

VULNERABLE ROAD USERS - DEFINITION

The current definition of Vulnerable Road Users (VRU) from the World Road Association's publication *"Diagnosis of Design and Operational Safety Problems and Possible Counter Measures"*:

The *"vulnerable"* road users are those road users who are at greater risk because of insufficient physical protection or because of relative high-speed differences with potential conflicting modes.

The definition does not prescribe specific user groups as *"vulnerable"*, leaving some flexibility. Generally, vulnerable road users are considered to be Pedestrians, Cyclists, Powered 2-wheel vehicles, and Non-motorised forms of transport.

Whereas road users in these groups complete the vulnerable road users definition in developed countries, for South Africa and other LMICs there can be additional vulnerable groups. For example, statistics indicate that in 2015, 38% of road fatalities in South Africa were passengers in motor vehicles. It would be a reasonable conclusion that these passengers are also vulnerable, and therefore need to be considered in the context of improving road safety in LMICs. Vulnerability of road users has a broader scope in LMICs.

GENERAL ROAD SAFETY IN SOUTH AFRICA

South Africa can be described as a middle-income country with one of the most developed economies in Africa. The level of economic development varies widely across the country, ranging from modern industrial conurbations to rural areas of subsistence farming.

The road network is equally diverse. The approximately 750,000 km of proclaimed roads include dual carriageway, multi-laned freeways, as well as unpaved roads which are barely more than dirt tracks.

The system of proclaimed National Routes, approximately 23,000 km, carry the bulk of the inter-city freight and passenger traffic, as well as high volumes of commuter traffic in the conurbations. The national routes, and most of the paved provincial routes, are designed to high geometric standards and are well maintained.

Nevertheless, South Africa suffers a very high incidence of serious road crashes, with the fatality rate up to 10 times higher than European countries. Accurate statistics are not readily available, but the fatality rate is estimated at between 25 and 30 deaths per 100,000 population. This equates to 40 to 45 fatalities per day.

Table 1, next page indicates statistics taken from the World Health Organisation's Global Status Report on Road Safety 2015.

There are many factors which contribute to these appalling statistics, but vulnerability on South African roads can largely be ascribed to road user behaviour. Excessive speeding and driving under the influence of alcohol and drugs are part of the problem, but are not the only aspects of a general recklessness on the roads.

THE WORLD ROAD ASSOCIATION'S ROAD SAFETY MANUAL

Road User Behaviour as a major factor in road crashes has largely been controlled in HICs through awareness campaigns and via rigorous law enforcement. The World Road Association's Road Safety Manual and other publications now shift the focus from behavioural factors to a more holistic view, encompassing the road infrastructure, the vehicle and the road user. This Safe System Approach aims at *"providing a road traffic system free from death and serious injury".*

The Road Safety Manual (RSM) does recognise that there are different challenges in LMICs relative to HICs. The importance of government leadership and accountability in improving road safety is highlighted in the RSM. In South Africa, these aspects are receiving attention via the adoption of the National Road Safety Strategy – 2016 to 2030. The PIARC RSM is a key reference document for all LMICs in addressing their specific road safety issues.

A MULTI – FACETED CHALLENGE

Improving the South African statistics for road fatalities and serious injuries is not entirely related to the design and maintenance of the road network. There are various social and economic issues which are contributing factors and which require a co-ordinated approach to road safety across a number of government ministries.

Specific highway operational factors which contribute to the road crash statistics include:

- reckless behaviour of motorists: excessive speeds; overtaking where visibility is limited; using cell phones while driving; disobedience of road signs and traffic signals; a general disregard for pedestrians;
- reckless behaviour of pedestrians: crossing busy freeways on foot; walking on the road instead of the

TABLE 1 - ROAD SAFETY ASPECTS - SOUTH AFRICA	
Population	52.0 millions inhabitants
Registered Vehicles	9.9 millions
Estimated fatalities *	13,300 to 17,000
Fatalities per 100,000 pop. *	25 to 30
Reduction 2004 to 2013	Nil
Pedestrian fatalities	33%
Passengers of cars and light vehicles	38%
Seat belt wearing rate	33%
General Law enforcement	3/10

* Records of fatalities and serious injuries from the South African police are not accurate. Hence, such statistics are estimates, generally obtained from hospital records and certified causes of death.

Illustrations 1 and 2 - Inappropriate control of livestock

Illustrations 3 and 4 - Reckless behaviour of pedestrians

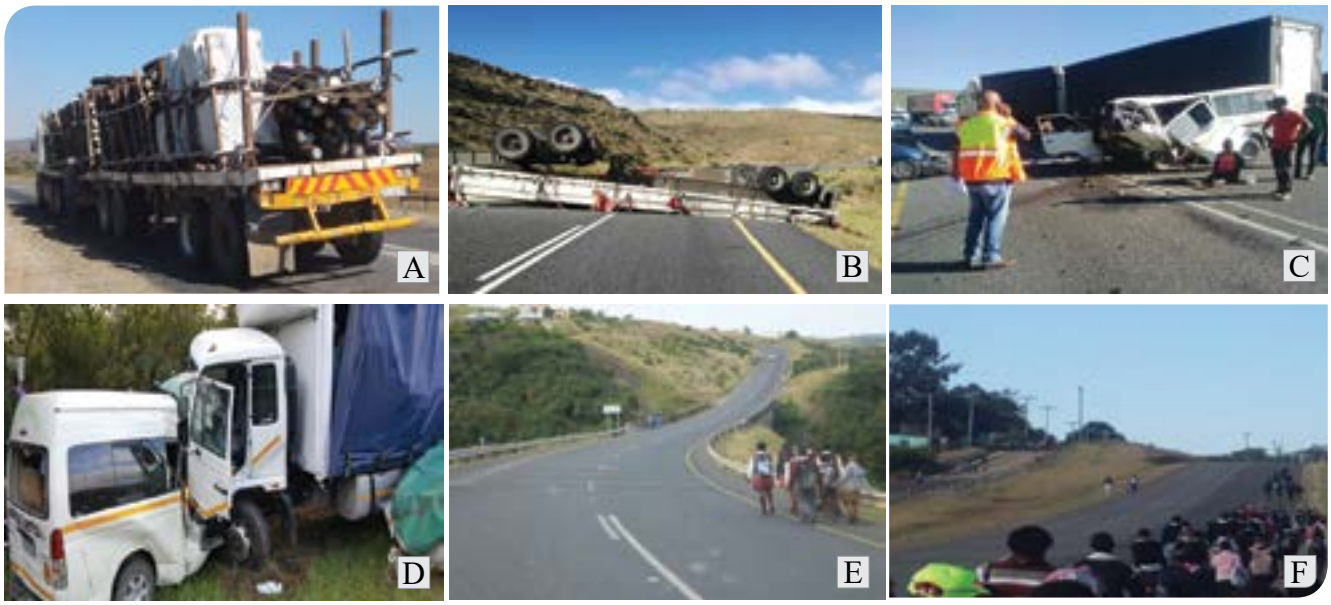


Illustration 5 - Additional factors relevant to the South African context
Overloading of heavy freight vehicles (5A et 5B) - Overloaded conventional buses or mini-bus taxis (5C et 5D) - Limited scholar transport system (5E et 5F)

sidewalk; jay-walking in town; failure to use underpasses and overpasses where provided;
- inadequate law enforcement: most fines issued to motorists are not paid; limited visible presence on roads; control mechanisms (permanent speed cameras and weigh-stations) are often not maintained or manned;
- inadequate control of livestock: herding livestock across and along highways is prevalent in rural areas;
- overloading heavy goods vehicles: this affects the braking ability of the vehicle and the severity of impacts with other vehicles. Overloaded vehicles warn one another of when and where weighbridges are being operated;
- overloading of public transport – taxis: it is not uncommon to find 30 passengers in a 16-passenger vehicle;
- unlicensed and unsafe vehicles: the risk of being caught is relatively low and the penalties are often ignored and not enforced;
- unlicensed drivers: as above.

The above factors have largely been addressed in HICs but remain a problem in LMICs.

Additional factors relevant to the South African context include:

- the percentage of freight moved by road – estimated at 88%. Overloading of heavy freight vehicles is problematic. Drivers are encouraged to undertake long haul trips without adequate rest breaks;
- limited commuter rail services – commuters rely on road transport, either in conventional buses or mini-bus taxis. Crashes involving mini-bus taxis result in multiple fatalities and occur frequently;
- limited scholar transport system – meaning that scholars walk to school and back. In rural areas, scholars use national and provincial roads due to a lack of paved local roads and footpaths;
- inter-city rail service virtually non-existent – again placing reliance on road transport;
- poor town and spatial development planning in some areas - Schools and other facilities are often located on the opposite side of rural highways from residential areas. Long commuter road journeys are required on public transport of questionable roadworthiness. There is also a historic failure to provide specific pedestrian and cycle facilities.

Whereas these factors are not directly related to highway design and operation, they do add to the number of VRU's using the roads.

INITIATIVES AND SOLUTIONS - EDUCATION

The South African National Roads Agency Ltd (SANRAL), together with other roads authorities, is implementing various initiatives in an effort to reduce road fatalities. Education and public awareness campaigns are among these initiatives, using social media networks to target younger people in particular.

There are approximately 9,000 schools within 5 km of a national road and up to 12 million scholars walk to school daily. A school outreach programme is in place to address the issue of road safety with scholars. There is also a lobby group aiming to have road safety included in the school curriculum.

SANRAL's *"Chek-i-Coast"* initiative uses social media, including Facebook, to convey the message of road safety. Content includes graphic images of crashes and the impact on the human body.

Illustration 6 - Typical illustrations from the Chek-i-Coast website and Facebook

These shock tactics have been used with effect in other countries.

APPROPRIATE DESIGNS

SANRAL's mandate was primarily aimed at the high mobility national road network. However, the agency has become responsible for second tier routes which pass through towns and rural areas where ribbon development has taken place. This presents a challenge in adapting design parameters originally developed for higher design speed rural highways.

The SANRAL 'Guidelines for Pedestrian and Public Transport Facilities on National Roads' was adopted in 2016. The Guideline largely follows the corresponding PIARC document. Provincial roads authorities in South Africa are encouraged to adopt the guidelines.

SANRAL has also adopted a policy of independent Road Safety Audits on all design projects. A pro-forma document and specification for conducting RSAs has been developed to ensure consistency across the agency's four regions. A programme of Road Safety Assessments on existing roads will be rolled out.

In conjunction with the latter, pedestrian hazardous locations are being identified and specific assessments conducted to implement appropriate mitigation measures.

TECHNOLOGY AND LEGISLATION

Embracing technology and associated amendments to legislation is another aspect of the efforts to reduce road deaths.

The use of 'Average Speed over Distance' measurements will help prevent excessive speeding, while *'High Speed Weigh-in-Motion'* technology is being introduced to combat overloading of freight vehicles. The technology is available and pilot schemes are planned. However, amendments to legislation is required to enable prosecutions to flow from the data captured.

Ongoing and improved liaison between road authorities and law enforcement agencies is being encouraged. The accurate reporting of crashes remains a challenge, and the general level of enforcement could be improved. Road crashes receive extensive coverage and public outrage during the December holiday period. Law enforcement is generally boosted, with the result that December is the safest (or least dangerous) month to travel, although fatalities are still unacceptably high.

Meanwhile, the number of crashes involving intoxicated drivers has led to the introduction of culpable homicide charges in such cases.

NATIONAL ROAD SAFETY STRATEGY: 2016-2030

The National Road Safety Strategy for 2016 – 2030 has been approved and adopted by government in early 2017. The strategy should ensure improvement in South African crash statistics going forward and aligns with UN Resolution 70/260 – Improving Global Road Safety, as well as with the PIARC Road Safety Manual.

Responsibility for the strategy's implementation rests with the Road Traffic Management Committee, a government department directly under the Minister of Transport. Responsibility and accountability are key aspects of the PIARC RSM's Safe System approach.

In recognising the behavioural and enforcement challenges, the specific interventions in the strategy include:

"Promoting responsible road user's behaviour, which is seen locally as the greatest contributing factor to road crashes. Changing behaviour can only be effected by ensuring that users are educated and aware of road safety, trained to behave appropriately, and effectively discouraged from transgressing laws through enforcement."

CONCLUSIONS

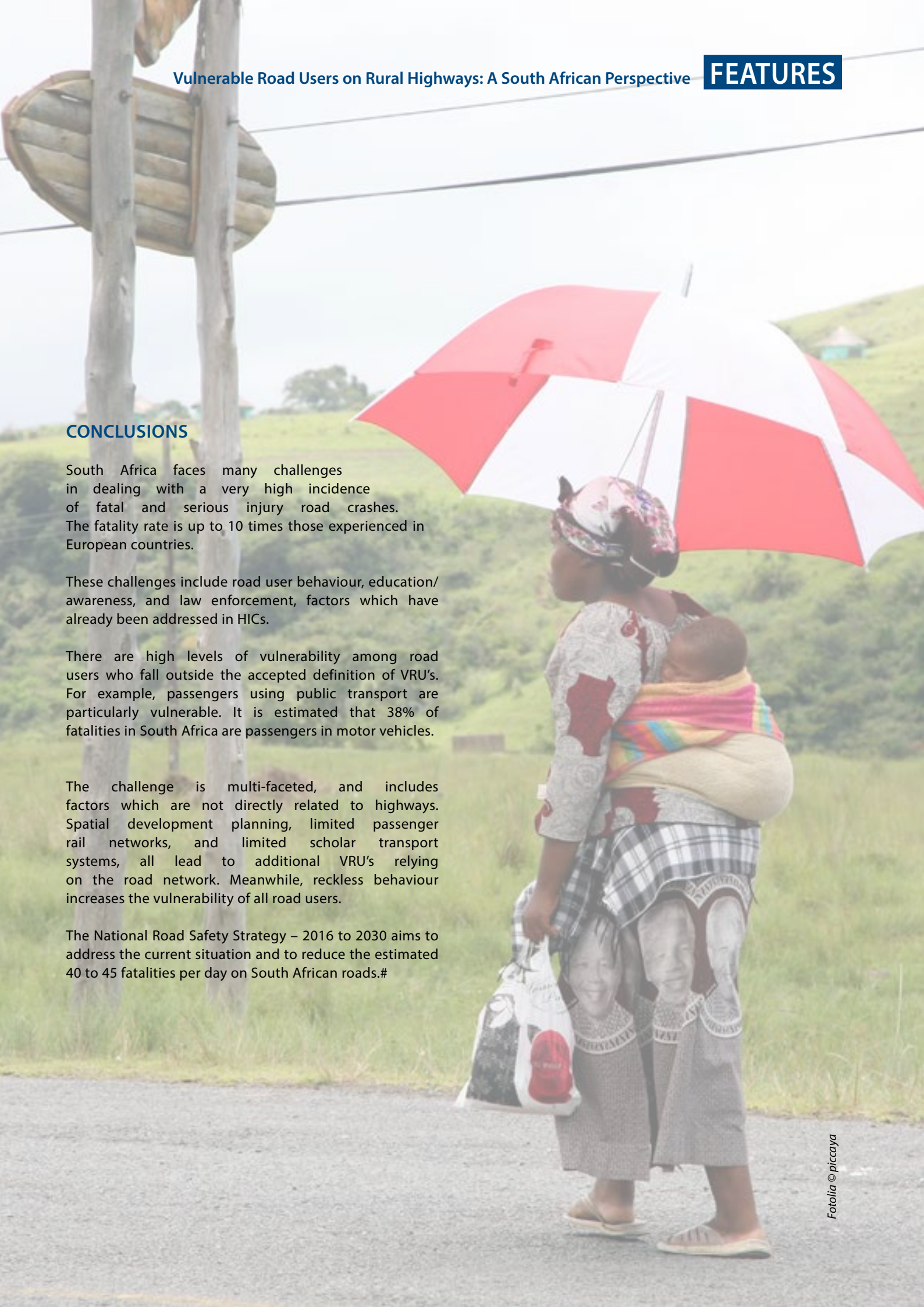
South Africa faces many challenges in dealing with a very high incidence of fatal and serious injury road crashes. The fatality rate is up to 10 times those experienced in European countries.

These challenges include road user behaviour, education/awareness, and law enforcement, factors which have already been addressed in HICs.

There are high levels of vulnerability among road users who fall outside the accepted definition of VRU's. For example, passengers using public transport are particularly vulnerable. It is estimated that 38% of fatalities in South Africa are passengers in motor vehicles.

The challenge is multi-faceted, and includes factors which are not directly related to highways. Spatial development planning, limited passenger rail networks, and limited scholar transport systems, all lead to additional VRU's relying on the road network. Meanwhile, reckless behaviour increases the vulnerability of all road users.

The National Road Safety Strategy – 2016 to 2030 aims to address the current situation and to reduce the estimated 40 to 45 fatalities per day on South African roads.#



Fotolia © piccaya

Vulnerable Road Users on Rural Highways - A Malaysian Perspective

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Illustrations © Authors

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Based on global road casualty statistics, someone dies every 30 seconds somewhere as a result of a road traffic crash, and this figure is rising. As a nation with rapid motorization and population growth for the last three decades, Malaysia does observe such a worrying scenario, though at a lower scale. Without increased effort to counter such a trend, the country will see road traffic crashes be at par with HIV/AIDS as a cause of death by 2030. In developing nations like Malaysia, investment in road infrastructure is focused on connecting urban areas and providing more accessibility to new developments. A simple correlation between the total road length and road deaths can tell whether more high speed but less safe roads are justified. Based on the current trend of road deaths, the Malaysian Institute of Road Safety Research (MIROS) has estimated that up to 10,716 lives would be lost in 2020 if nothing is done.

Crash statistics from 2005 to 2015 released by the Royal Malaysian Police revealed these:

- motorcyclists (including pillion riders) and pedestrians account for an average 62% of the total road deaths - more than half of them occurring on rural roads;
- the most common types of collision that cause deaths among motorcyclists are head-on, intersection and run-off;
- youths aged 16 to 30 constitute half of the total number of deaths among motorcyclists.

Unlike in developed nations, road safety policies have only been actively formulated over the last two decades, but are unable to keep up with the rapid growth in motorization due to rising population and urbanization. In rural areas, road upgrades are heavily invested to provide a higher degree of mobility to road user at the expense of some safety features e.g. segregated lanes for motorcycles and signalized crosswalk. Site constraints – very much due to the high cost of land acquisition – often put the designer in a difficult situation to abide by safety requirements. But at least advocacy campaigns targeting safety of vulnerable road users are still being actively carried out by the government through partnerships with private entities and non-governmental organizations.

In addition to its own advocacy programmes, the Road Safety Department (a government agency under the Ministry of Transport of Malaysia) for example, has been facilitating activities of road safety councils at States and national levels. Road safety councils are formed in each of the States of Malaysia, comprising government and private agencies, as well as non-governmental organizations (NGOs) as a medium of communication between government and the public on road safety advocacy matters. Safe driving etiquette such as respecting speed limits, stop on red, no misuse of emergency lanes and wearing helmets have always been the main focus of their road safety campaigns.

Such campaigns, although needed to serve as a reminder to road users, are not adequate for effective reduction in road trauma involving vulnerable road users. Their lackadaisical attitude towards safety and unsafe behaviour is not helping them either. Many are found not wearing the helmet nor using the overhead bridge when crossing the road especially in rural areas. A study revealed that about 35% of those 60% motorcyclist who died on rural roads had no proper license. For pedestrians, 65% of all deaths and seriously injured were believed to have been caused by jaywalking or reckless crossing. Many of those who died are young working adults, and perhaps the only breadwinner for the family. Any compensation scheme would surely be insufficient to provide the same benefits to the victims' family as before, prompting other family members to look for extra income at the expense of other social aspects such as education. Moreover, their contribution to the nation socio-economic progress is cut short prematurely, costing the country in lost earnings. A model developed by the International Road Assessment Programme (iRAP) estimates that the cost of fatal and serious road traffic crashes could be as large as 5% of Gross Domestic Product (GDP) for a middle-income country like Malaysia (McInerney, R., 2014).

Travelling on rural roads, those high-speed facilities pose a higher risk to motorcyclists and pedestrians compared to urban areas. Aside from the high traveling speed, the likelihood and severity of a road crash are further increased in rural areas where there are no proper segregation measures in place. In fact, motorcyclists who

Illustration 1 - Non-exclusive motorcycle lane along an inter-urban primary roads in Malaysia

care for their safety by using the non-exclusive motorcycle lane (without physical separator) are forced to travel in close proximity with roadside objects such as trees, utility poles, deep open drains, etc. *(illustration 1)*. Pedestrians, on the other hand, have no choice but to gamble with their lives by crossing high-speed roads when there are no proper crossing facilities such as the overhead bridge within reasonable distance from their point of daily activities. Even when available, the elderly, for sure, are not tempted to use it. The worst situation for pedestrians is when school children are exposed to high risk of road crashes due to the school that is located next to the main road *(illustration 2)*.

The good news is that road traffic crash is preventable and its severity is manageable. Motorcycle helmet law applicable to both the rider and pillion rider has been in place for a long time but the only missing piece in the government effort to improve motorcycle safety would be to promote the use of certified helmet. Despite having standards (adopted from UNECE R22) to ensure the quality of helmets, sub-standard helmets are still widely available and are more affordable than a certified one. Likewise, traffic laws requiring the use of marked pedestrian crossing is well known for decades, but non-compliance rates are remarkably high in rural areas. That is why the government has introduced road safety education among school children, quite a formal kind of teaching-learning process where essential knowledge and skills are embedded in the existing English and Malay language syllabuses. Nevertheless, this form of road safety 'vaccine' has yet to show significant outcomes, not until the school children are old enough to drive and ride.

From the perspective of road safety engineering interventions, a wide selection of countermeasures has proven worldwide to be able to slash road deaths. In Malaysia, the first motorcycle lane with physical barrier was found on average to reduce motorcycle crashes by 39% and fatality by 600% (Radin Umar, R. S., 2006). Those without physical separator (designed as close as possible to the available design guideline) were found to have reduced motorcycle crash risk by as much as 83% (Alvin Poi, 2016).

Such major improvements can only be seen through road upgrading projects to increase the capacity and safety of the road traffic. Aside from that, other smaller scales of road improvements are targeted at localized spots e.g. intersections and sharp bends where a significant number of crashes have occurred. These however require a longer time frame before allocation is approved due to budget constraints. Road safety audits, similar but rather proactive in nature, are conducted to identify potential hazardous conditions to the road users. For instance, the need for signalization at marked crosswalk due to increased motorized traffic and pedestrian activities in certain small towns.

On a larger scale of assessment, high volume roads are star rated for safety conditions, providing the government another means of prioritization approach in infrastructure improvement. The International Road Assessment Programme or iRAP was launched early 2016 by the Ministry of Transport whereby a steering committee comprising key agencies across different ministries was set up under the Cabinet

Illustration 2 - A typical traffic scenario in front of a school in a rural area

Committee for Road Safety. As of April 2017, more than 2,000 km of high speed inter-urban (rural) roads have been assessed under the programme. With coordinated effort through the steering committee, many critical areas were treated to improve the safety conditions.

One critical issue as highlighted in the assessment is the speeding behaviour among road users, which significantly influence the star ratings (MIROS, 2017). The government has undertaken a nationwide programme to install enforcement cameras to curb speeding and red light running on the expressways and rural primary roads at crash prone locations. An evaluation of the programme revealed that the risk of crashes is significantly reduced due to increased compliance with the speed limit and the red light (MIROS, 2016). This is foreseen to produce a huge impact in road trauma reduction soon, as far as changing driver behaviour is concerned.

However, humans do make errors, and not even the most careful person could spare being struck by other errant motorists. Modification to the built environment is costly, causing many impactful road engineering treatments delayed to make way for other national expenses. For example, though it would potentially prevent five deaths per kilometer over a 20-year period (iRAP, 2009), shoulder widening could easily cost a quarter million Malaysian Ringgit per kilometer. To further address the problems faced by motorcyclists and pedestrians, and to assist drivers in minimizing errors in detecting these vulnerable road, MIROS is now exploring in-vehicle Safety Assist Technologies (SATs) systems such as the Blind Spot Technology (BST) and the Autonomous Emergency Braking (AEB) systems. Having this system in a vehicle is considered as one of the rating protocols in the ASEAN New Car Assessment Programme for assessment starting 2017.

So far, it seems that a significant reduction in the number of deaths of VRUs is hard to come by in the near future. Many road safety efforts are put in place but their outcomes have not shown good statistics. But one thing for sure – stepping up regulation and enforcement through political will is utmost needed if Malaysia is to halve the number of number of global deaths and injuries from road traffic accidents by 2020 in line with one of the United Nations Sustainable Development Goals.#

A Short History of Polish Roads - Modern Times

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The 18th century brought the Enlightenment and attempted to revive the dying areas of State life, regulate the principles of its existence, which could also be felt in the area of roads. A Good Order Commission (Komisja Dobrego Porządku) was established, the mission of which was to oversee the construction and proper maintenance of roads and bridges. In 1765, a Corps of Cadets was established, followed by the 1788 Engineering Schools in Warsaw and Vilnius, which provided education in line with modern technical knowledge of that time. However, most roads were still not paved.

In 1796, the first European iron bridge was built over the Strzegomka River in Łażany (destroyed in 1945 by a Soviet tank trying to cross it.)

Illustration 1 - Bridge in Łażany © http://regionfakty.pl/historia/okragle-urodziny-mostu

At the same time, the Polish King began to receive income from postal services. This became a driving force behind organizing and developing the network of post roads, which resulted in constructing 22 routes totalling 750 miles over just a few years. Mail was exempted from all customs and duties. Postal stations were built in cities and towns every 2-6 miles, and they took over the role of inns for travellers, with stables, accommodation, and meals. However, there was still no passenger transport. These well-maintained Polish roads were to be used later by Napoleon Bonaparte to transport horsemen, cannons, and troops on his way to Russia.

Illustration 2 - Engraving of the Headquarters of the General Roads and Bridges in 1819

In 1772, 1793, and 1796 Prussia, Austria, and Russia partitioned Poland, depriving it of independence and autonomy. Roads, similarly to other areas of life, were taken over by the partitioning powers and developed according to their own policies.

The Russian Partition allowed the existence of the Kingdom of Poland, a surrogate Polish state within the bounds of the Russian Empire with a wide degree of autonomy. It was there that the «French stagecoach» was first launched, transporting a maximum of 6 people between Warsaw and Poznań. In 1819, the General Directorate of Roads and Bridges (Dyrekcja Jeneralna Dróg i Mostów) was established – a strictly technical unit, one of the first public road administrations in the world. Franciszek Ksawery Christiani became its head.

Illustration 3 - Construction of a bridge on the Niemen River, interwar period

Illustration 4 - Road construction Kampina - Nieborów, 1927

Roads were state-owned, and landowners could be expropriated for the purpose of constructing new ones. Road infrastructure was considered a way to develop and reconstruct areas devastated during the Napoleonic wars. Ambitious Polish engineers planned a modern network of roads and bridges, not always consistent with the royal routes that had existed for centuries, but of significant military importance. Most of the roads that were built exist to this day, and they are easily adapted to existing needs. A road service was established; uniformed, trained staff was assigned to individual road sections, road infrastructure developed and traveller safety was improved.

Attempts to maintain Polish identity were not perceived favourably by czarists. After Polish uprisings against the Russian authority, Polish autonomy was significantly limited. Over time, Russia completely took over road and state administration. It should be noted that Polish technical ideas and know-how were not completely wiped out. Despite many impediments and persecution, Polish engineers found shelter in other countries, and those who remained took care of educating new generations.

In areas under Austrian rule, the situation concerning roads was different due to more mountainous terrain. Polish engineer Jan Gross introduced road construction standards consisting in laying four layers of crushed stone or gravel that did not exceed half a metre, inspired by McAdam's surface course. He was the first to cover wooden thoroughfares on bridges with the same pavement as roads. The road network was being developed, and reinforced-concrete bridges were built. These roads were better by far than those found in the Russian Partition. At the beginning of the 19th century approximately 2,900 kilometres of roads were built, which survived dozens of years despite the lack of funding for maintenance.

The Prussian Partition divided the lands into provinces with separate regulations, including those concerning roads. Fixed annual allowance was spent on roads; it was also possible to take interest-reduced loans for road construction. The development of these areas did not differ from other lands under the partitioner's rule. Roads were important for military purposes, and the road network was systematically developed and maintained properly.
Poland did not exist on the maps of the world for 123 years. However, the nation's spirit did not collapse. After independence was regained on 11 November 1918, Polish engineers returned, joining the reconstruction of the country. Territories which once more became Poland had different regulations, standards, and road widths. The roads were generally in a disastrous condition, mainly as a result of World War I. There were approximately 44,000 kilometres of paved roads, including approx. 500 km improved with clinker bricks, and almost none with bitumen. Road construction equipment also posed a problem. Farm equipment drawn by horses was not efficient. Mechanisation was on a negligible level. For efficient functioning, it was necessary to reorganize the road network, taking into consideration the already-developing rail and car transport. Poland was to become economically and socially strong once again.

Based on the needs of the newly re-formed country, principles for its functioning were established. The road administration was consolidated through the adoption of the 1920 Road Act, the provisions of which remained partly applicable up to the 1980s. It served as a foundation for a 1923 road expansion plan that included the construction of macadam and paved roads, and the reconstruction of wooden bridges into permanent ones, all over a period of 20 years. The difficulty in obtaining financial resources did not prevent the reestablishment of road-building education, research and the organisation of domestic extraction of stone. Clinker plants were re-established, and several new ones built. Engineers returning to the country who were involved in the reconstruction carefully designed

and implemented modern solutions for building paved, concrete roads using tar and bitumen produced from Polish oil. Four Polish road congresses were held. Following the example of the World Congress in Paris, it was an opportunity to exchange experience, discuss and present new technical and material solutions.

Many permanent bridges were built. The world's first welded bridge in Maurzyce, built in 1929 and used until 1977, is an engineering marvel. Nowadays it is not connected to any road, but can be seen by visitors. Domestic state-owned and private construction companies did not have sufficient capacity, therefore almost 46% of all roads constructed in the interwar period were made by foreign enterprises.

World War II did not allow Poland to fulfil the objectives completely, but in 1939 Poland already had 64,500 kilometres of paved roads. Only roads of strategic, military importance were maintained during the German occupation, utilising the slave labour of people imprisoned in Nazi camps.

The war damage was enormous. Retreating German forces blew up bridges and roads, while German and Soviet tanks completed the devastation. During the war, the Polish government-in-exile in London was preparing post-war plans for highway construction, to incorporate them into the European transport system, and was developing appropriate legal regulations.

The end of the war constituted a challenge for Polish engineers once more. Borders changed again, so that Poland lost many territories and regained other ones. New differences between existing roads emerged, and correcting them was another challenge. In the post-war years, the focus was primarily on restoring transport connections to improve the functioning of the crippled state, and then on modernising roads, adapting them to heavy traffic through profiling bends and corners, improving pavements, constructing viaducts, and rebuilding bridges and crossings.

Illustration 5 - Bridge in Maurzyce today

Illustration 6 - Destroyed Bridge IV, 1946

Significant depopulation, lack of human resources and road workers revived road-building education. Resource problems emerged after the country began to rebuild. The matter of highways was not taken up until the 1970s.

The second half of the 1950s brought a revival in terms of expanding and improving road infrastructure in smaller towns, including greater accessibility to public transport and domestic production of trucks and passenger cars. Better connections were made between larger cities, the overall condition of roads improved, and despite the fact that the road network was growing at a slower pace than assumed by socialist programmes, it was still progressing.

Cooperation established in the 1970s between the government of the Polish People's Republic and the UN concerning the implementation of the «Road network development» programme introduced positive changes. This was when the matter of highways returned to the spotlight. Transport connections were improved by building ring roads and expressways, but it still was not enough. Roadside infrastructure was also taken care of by creating places for stopovers, observation decks, parking areas decorated with statues, and monuments.

Many investments have not been completed, which is why we can still see partly asphalted roads leading to nowhere in the middle of a forest, rows of columns where a proposed – and never built – viaduct was to be erected, bridges on

meadows, waiting for a river to be dug up and a road to be built. There are also straight «*runway*» sections, approximately 2 kilometres long and 10 metres wide, among winding roads of minor importance. It is an example of the state infrastructure preparing for an armed confrontation with the capitalist West. After 35 years of new Poland's existence, a total of 54,000 kilometres of roads and 127 kilometres of highways had been built, while 87,000 kilometres of roads had been modernised.

As the Polish People's Republic was not able to bear the entire financial burden by acting on too many fronts at once, an economic reform introduced self-financing of companies and local governments, which resulted in huge confusion and chaos. At the end of the 1970s, the focus has been mainly on current maintenance rather than development.

The 1980s were a period of tumultuous political change. A new Act on Roads adopted in 1985 shaped the organisational side of road building anew. In 1989, Poland fully regained its independence, breaking away from Soviet influence. The following years separated road management and construction, which gave this field a form better known to us today. The opening of borders and return to Europe created new perspectives and challenges in rebuilding the country.

The General Directorate for National Roads and Motorways, the successor of the first state road administration established in 1819, currently manages a network of 17.5 thousand kilometres of national roads. Nowadays travellers have 3,200 kilometres of express roads, including 1,627 kilometres of motorways and 1,552 kilometres of expressways, at their disposal. A total of 2,100 kilometres of roads are currently under construction.#

Illustration 7 - Training of road workers, Dąbrowa Tarnowska, 1947

Illustration 8 - Sample parking in the 1970s

Illustration 9- Winter road maintenance using snow ploughs, 1970s

PUBLICATIONS

http://www.piarc.org/en/publications/technical-reports

TECHNICAL COMMITTEE 4.1

MANAGEMENT OF ROAD INFRASTRUCTURE ASSETS

Management of road assets: Balancing of environmental and engineering aspects in management of road networks

2017R05EN, 978-2-84060-455-6, 58 pages

The objective of Working Group 3 (WG3) of The World Road Association (PIARC) Technical Committee (TC) 4.1 was to establish a global perspective on how environmental aspects are considered and addressed in the road asset management process compared with traditional engineering oriented road asset management.

There are established environmental legal frameworks in many developed countries that create a statutory obligation on road authorities and their suppliers. Some agencies also adopt guidelines for sustainable maintenance under the legal framework. In developing countries, the legal framework is less established.

Environmental impacts are considered in the design and maintenance processes in many countries; however, environmental aspects are not necessarily given high priority. Furthermore, most agencies use only engineering judgement and economic indicators such as life-cycle costs (LCC) to prioritize projects.

Although no explicit guidance on how to incorporate environmental aspects in asset management was identified, there are a few good examples of asset management practices that take environmental considerations into account. For example, value management in the UK and risk-based management in the US consider environmental aspects as part of the decision-making criteria.

TECHNICAL COMMITTEE 4.4

EARTHWORKS AND UNPAVED ROADS

Optimal use of local materials in earthworks

2017R04FR, in French only, 978-2-84060-473-0, 67 pages

The use of local materials available on the site of a road project is a major concern in the context of sustainable development and perfectly meet socio-economic and environmental criteria.

Following a previous survey carried out on this topic during the 2008-2011 cycle, it appeared necessary to launch another survey in order to cover a wide range of knowledge to be shared on the construction of paved and unpaved roads. The aim was to collect information on cases of use of local materials in extreme conditions (frost, drought, torrential rain), and on cases of declining resources in materials such as laterite, which is of particular interest for countries in Africa and Asia, both continents being well represented within the technical committee.

Responses to the survey have enabled to identify two new families of marginal materials (available locally): materials qualified as industrial by-products and materials in extreme climate situations or too dry materials. The responses have also enabled to complement the family of fine, clayey or organic materials (marine dredging sediments). It was also found out that the use and reuse of laterite materials is of vital importance for a number of countries. For each for these new families of materials, the report specifies the characteristics of the materials, the use intended in the structure, the improvement aimed at, possible feedback from experience, but also the other uses envisaged.#

Deutsch

Straßenverkehrssicherheit: Ansätze, Strategien und Aktionskampagnen

Die Straßenverkehrssicherheit ist mittlerweile ein internationales Thema. Straßenbezogene Risiken müssen heute global angegangen werden, wobei das Ausmaß der Risikominderung allerdings sehr unterschiedlich ist. Bei Betrachtung der Opferzahlen pro Kopf oder bei der Segmentierung der Analysen nach Opfern sind tatsächlich große Abweichungen zu beobachten. Solche Diskrepanzen sind den Entscheidungsträgern bekannt, wie Roberto Arditi in seiner Einführung zu Ländern mit niedrigem und mittlerem Einkommen unterstrich.

Unsichere Straßenverhältnisse sind nach wie vor weit verbreitet, wobei ähnliche Tendenzen zwischen einzelnen Ländern zu beobachten sind: Fahren mit überhöhter Geschwindigkeit, Fahrzeugbetrieb trotz verminderter oder sogar fehlender Tauglichkeit, missbräuchliche Fahrzeugnutzung, unzureichende oder fehlende Sicherheitsmerkmale sowie defekte Straßeninfrastrukturen und in einigen Fällen das völlige Fehlen einer sicheren Straßenumgebung.

Der Fokus liegt auf der Gestaltung des „großen Ausbruchs", wie Angus Deaton, Nobelpreisträger für Wirtschaft des Jahres 2015, sagte, der sich mit den zivilisatorischen Fortschritten in den Bereichen Gesundheit und Armutsbekämpfung auseinandersetzt. Ein solcher Ausbruch muss heute für die Bemühungen zur Verbesserung der Straßenverkehrssicherheit gestaltet werden. Dies erfordert eine Sensibilisierung auf höchster Ebene, wie die Umsetzung von Maßnahmen im Jahrzehnt der Straßenverkehrssicherheit durch die Vereinten Nationen belegt.

Die Senkung der Verkehrsunfallzahlen erfordert die Mobilisierung personeller und finanzieller Ressourcen sowie den Austausch bewährter Verfahren und Lösungen. Die Weitergabe von Wissen an ein möglichst breites Publikum ist für die Straßenverkehrssicherheit daher zu einer zentralen Herausforderung geworden. Das PIARC-Handbuch zur Straßenverkehrssicherheit (Road Safety Manual; road-safety.piarc.org) und seine jüngste Aktualisierung geben darauf eine partielle Antwort, wie S. V. Wong in seinem Artikel vermerkt.

Diese Sonderausgabe zielt auf eine Konsolidierung der Sicherheitsanstrengungen ab. Sie stellt eine Auswahl von Beiträgen aus PIARC-Seminaren dar. Diese Seminare sind wertvolle Foren für den Austausch und die Vermittlung aktueller Praktiken. Die Artikel umfassen alle Kontinente und vermitteln originäres Fachwissen. Der redaktionelle Ansatz sieht eine besondere Förderung der Beiträge von Ländern mit niedrigem und mittlerem Einkommen vor, um deren Herausforderungen aufzuzeigen. Mit der Offenlegung des gesammelten Know-hows sollen ein gewisser Optimismus geweckt und gleichzeitig solides Fachwissen vermittelt werden.

Der Beitrag von R. McInerney, B. Tuner und A. Barlow zeigt, wie aus einem Bewertungssystem für das Straßennetz auf der Grundlage von Audits ein leistungsfähiges Instrument zur Verbesserung der Ergebnisse bei der Straßenverkehrssicherheit schafft. A. Mendoza und M. Cadengo stellen eine konkrete Anwendung dieses Ansatzes auf Mexiko vor. D. Schmitt untersucht, was von Prüfungs- und Audit-Instrumenten, die für die Sicherheit von Fußgängerinfrastrukturen entwickelt wurden, für den Schutz gefährdeter Verkehrsteilnehmer zu erwarten ist. Der Einsatz solcher Instrumente führt unter anderem dazu, dass Sicherheitsziele sowohl in einen integrierten Ansatz zur Organisation des Mobilitätsbedarfs als auch in die erfolgreiche Umsetzung einer städtebaulichen Strategie einbezogen werden müssen. L. Carnis achtet bei der Priorisierung und Evaluierung von Verkehrssicherheitsansätzen und Aktionskampagnen sehr genau auf Details. Angesichts mehrerer Herausforderungen erfordert eine solche Priorisierung eine noch stärkere Schwerpunktsetzung, wie das Interview mit H. Gomez über die Straßenverkehrssicherheit in Lateinamerika zeigt. Die Beiträge von S. Robertson für Südafrika und S. Wong, A. Poi, M. Amirudin und M. Radzi für Malaysia, die insbesondere schutzbedürftige Nutzer im Visier haben, bieten ebenfalls sachdienliche und aufschlussreiche Erfahrungsberichte über die Größenordnung der Probleme und ihre potenziell wirksamen Lösungen.

Diese Sonderausgabe widmet sich ganz der Verkehrssicherheit und lädt den Leser zu einer ausgedehnten Reise zur Entdeckung der verschiedenen Herausforderungen im Bereich der Straßenverkehrssicherheit ein. Abgesehen von der Exotik einer solchen Reise ist diese Sonderausgabe vornehmlich ein Appell an die Leser, sich zu engagieren.

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