

Road safety in Low- and Middle-Income Countries – Analysis and Recommendations

Isabela Erdelean¹[0000-0001-8694-0447], Andrea Schaub¹[0000-0003-1482-5946], George Yan-
nis²[0000-0002-2196-2335], Julia Roussou²

¹ AIT Austrian Institute of Technology, Giefinggasse 4, 1210 Vienna, Austria

² National Technical University of Athens, Patission Complex 42, 10682 Athens, Greece
isabela.erdelean@ait.ac.at

Abstract. Road accidents continue to be a major cause of death and serious injury for low- and middle-income countries (LMICs). The overall goal of this study is to increase road safety in LMICs by providing them with easier access to knowledge developed by PIARC (World Road Association). The basis of the study was the in-depth analysis of more than 45 PIARC documents with the aim of providing insights to road authorities, operators, planners and other relevant stakeholders into several road safety areas. The PIARC resources were reviewed and analyzed considering eight major road safety areas, based on the Safe System Approach, namely management, data, speed, vulnerable road users, human factors, infrastructure, vehicles and tunnels. This paper summarizes the main challenges identified for each safety area as well as providing a set of recommendations. These findings, while targeted at road transport stakeholders of low- and middle-income countries, can be considered valuable for all countries looking to improve safety on their roads.

Keywords: Road safety; Low- and middle-income countries; Safe System Approach.

1 Introduction

Fatalities and serious injuries represent an unacceptable consequence of the road transport system globally. Road accidents continue to be a major cause of death and serious injury for low- and middle-income countries (LMICs). At global level, 90% of road fatalities occur in LMICs, a number – three times higher than in high-income countries [1]. The goal of the PIARC Global Road Safety Knowledge Exchange project is to increase road safety in LMICs by providing road authorities, operators, planners and other relevant stakeholders easier access to a wide depth of knowledge developed by PIARC (World Road Association). The basis of the study was the analysis of more than 45 PIARC technical reports, proceedings of seminars, conferences, case studies, workshops, manuals and webinars. The review considered eight major road safety areas, namely management, data, speed, vulnerable road users (VRUs), human factors, infrastructure, vehicles and tunnels.

1.1 Safe System Approach

When addressing road safety, the Safe System Approach is one of the most effective methods of addressing fatal and serious accidents on the road network. High-income and low- and middle-income countries alike are encouraged to follow the Safe System Approach in order to achieve both Vision Zero and global targets of reducing fatalities and serious injuries. The elements of the Safe System Approach are infrastructure, speed management, vehicles and road user behavior [1].

Practitioners from LMICs acknowledge that there is often a lower level of compliance with road rules in most low- and middle-income countries, when compared to HIC. Nevertheless, focusing on improvements in infrastructure and vehicle safety will contribute to providing a forgiving road system for accidents arising from human errors.

2 Methodology

2.1 Low- and Middle-Income Countries

Based on the World Bank classification for countries by income, low- and middle-income countries were defined as low-income countries and lower middle-income countries as shown in Fig. 1.

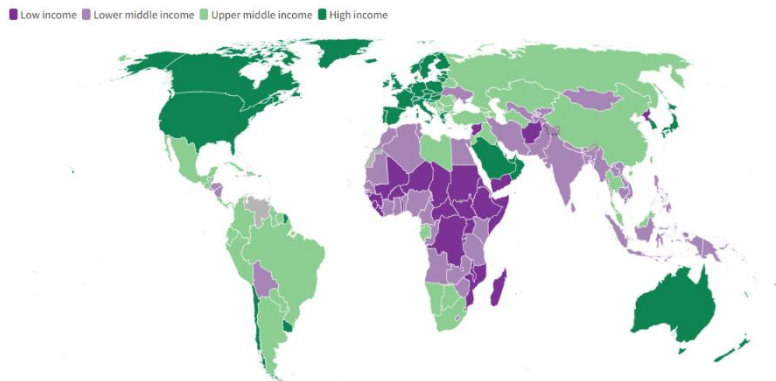


Fig. 1 The world by income 2020. Purple-colored countries designate LMICs considered within this study (Source: [2])

2.2 Literature review process

To identify and collect the relevant literature, the PIARC knowledge base was reviewed. All the documents are free to access. Reports, case studies, conferences proceedings, seminars, workshops and webinars were considered for the years 2015-2022. Several key words were used to filter the results, including “road safety”, “Safe System approach”, “speed”, “infrastructure”, “vulnerable road users” and others.

The review process consisted of two steps: (i) a brief screening to identify the most relevant documents and (ii) an in-depth review of the filtered documentation.

This resulted in more than 60 online resources consisting of proceedings, reports, webinars, case studies etc. In addition, the online PIARC Road Safety Manual [1] and the PIARC Road Tunnels Manual [3] were reviewed, as they also include valuable information targeted specifically at LMICs. After the first step, 18 documents were considered out of scope, leaving approximately 45 resources for a comprehensive analysis.

3 Results and discussion

3.1 Management Strategy/Policies

While 87% of LMICs have established a lead agency to guide the national road safety efforts, 37% of low-income and 25% of middle-income countries do not have a national strategy for road safety [1]. In many LMICs, the organizational structure of the management system may suffer from shortcomings, such as lack of leadership, lack of political priority, lack of funding and missing expertise [4], [5].

In order to ensure road safety management and to build road safety expertise, the following actions were identified:

- Develop a strong lead agency, with a set of local guidelines and regulations.
- Develop a robust road safety data system.
- Develop university road safety programs at bachelor and master level.
- Connect to regional road safety observatories and international networks of universities.
- Build centers of road safety excellence to develop road safety management and research capacity at national level.

3.2 Data

Efforts to reduce accidents in low- and middle-income countries are hindered by the lack of accurate crash and fatalities data. A wide range of relevant data types are needed to increase road safety, including road condition and maintenance-related data, traffic data, large scale data on road users' behavior, road safety related data and others. Furthermore, data quality is of high importance, as misleading data can lead to wrong conclusions and ineffective decisions being made [1], [6].

To address these challenges, the following recommendations can be taken:

- Better access to data on the effectiveness and costs associated with specific measures and investments can lead to further improvements and support for a broader implementation of road safety solutions.
- Training of data entry staff and police, improvements in the data collection tools and methods (e.g., crash report documents and devices, sensors) and quality assurance measures can contribute to the enhancement of data quality and reliability.
- Enforcement measures to ensure reporting of accidents, e.g., by making it a legal requirement, should be employed.

3.3 Speed

Speed is considered one of the most important risk factors of road accidents, influenced also by behavior issues such as slow reaction time, fatigue, difficulty in understanding complex traffic situations and “crowd-behavior”. An increase of 15% over the mean speed leads to an 88% increase in road accident fatalities [7], [8].

To tackle speed-related challenges, the safety recommendations are:

- Speed limits must be credible, homogenous, consistent, visible and maintained over time to increase driver compliance.
- Speed management requires the planning and designing of appropriate road layouts and networks to ensure safe travel speeds.
- Solutions such as speed bumps, lane narrowings, new pedestrian crossing solutions and chicanes are low-cost essential techniques for LMICs.
- The potential benefits of speed control systems such as Intelligent Speed Assistance (ISA) should be explored for cars, motorcycles and motor-tricycles.

3.4 Vulnerable Road Users

Developing countries have a greater variety of traffic users involving slow-moving and vulnerable non-motorized road users as well as powered two-wheelers with fast-moving motorized vehicles. Moreover, VRU fatalities are higher in LMICs due to lack of resources to maintain safe infrastructure, poor post-crash response and unsafe user behavior due to lack of training and education [4], [5], [9].

The following measures have been identified for increasing VRU safety:

- A paradigm shift from designing roads for cars to focusing on vulnerable road users is needed. Road design should include a self-explaining and failure-for-giving road accounting for the needs for all road users.
- Measures to enhance VRU safety along road sections include wider and paved shoulders, proper crossing facilities, separated footpaths and lanes for cyclists/mopeds and appropriate road lane widths.
- To ensure compliance, a combination of communication and education campaigns and enforcement measures should be employed.

3.5 Human Factors/Behavior

Despite progress in improving legislation across key human behavior risk factors – speeding, drink-driving, helmet use, seatbelt use and driver distraction – enforcement remains a major challenge in most countries, particularly LMICs [1], [4], [10].

To tackle the human behavior related challenges, several recommendations can be provided:

- The road transport system needs to anticipate and accommodate for human errors and prevent fatalities and serious injuries. This includes road infrastructure that facilitates safe behavior such as clear road signage, traffic calming designs and physical separation of road users.

- Road safety evaluations and inspections should be made by an interdisciplinary team including human factors and behavior experts.
- Developing countries should consider strategies that have been successfully implemented in other countries. This might include the adoption of technologies such as alcohol interlocks and seat-belt warning systems.
- Legislative measures such as setting speed limits, establishing blood alcohol limits and mandating the use of protective equipment should be enacted and enforced.

3.6 Infrastructure

Road infrastructure often represents the most significant factor contributing to the severity outcome of an accident. Challenges related to the successful implementation of infrastructure measures include cost, design issues, maintenance and acceptance/compliance issues [1], [4], [5], [7], [11].

The ensuing road infrastructure recommendations can be pinpointed:

- Clear and well-defined policies related to the implementation of Safe System infrastructure are needed to drive road safety improvements.
- Risk assessments should be performed systematically by road authorities for the whole network when possible, as well as at known high-accident locations.
- Developing countries should prepare for automation by implementing road infrastructure improvements related to pavements, lane markings and visibility of traffic signs, leading to safer roads for vehicles at all levels of automation.

3.7 Vehicles

In many LMICs, vehicle safety is not sufficiently regulated through design standards or maintained through mandatory vehicle inspection schemes. A particular challenge is related to overweight vehicles, where overloading for cost savings and lack of enforcement leads to increased safety risks [1], [12], [13].

Vehicle safety can be improved through the following measures:

- The adoption of high-quality harmonized safety standards is necessary, through mandatory certification and registration systems for new and used vehicles, based on safety requirements and combined with routine inspections.
- A combination of passive safety measures and systems such as electronic stability control could provide a strong improvement in vehicle safety.
- With regards to automation, LMICs should focus on deployment of the most mature safety-related services and starting with small pilots.

3.8 Tunnels

The consequences of a serious accident in a tunnel environment are potentially more severe than on the open road. Tunnels require specific approaches to identify and evaluate the need for improvements [3].

The recommendations for improving road safety in tunnels are:

- The design of road tunnels and their operation should consider human factors; the measures implemented for safety should be easily understood and adopted by the users.
- Specific and appropriate training is necessary, as well as establishing optimum protocols and post-crash intervention sequences.
- Risk assessment can be used to address and evaluate the safety features of a tunnel system.

4 Outlook

The road transport system needs to anticipate and accommodate for human errors. Building awareness of the Safe System Approach's application is a crucial step for low- and middle-income countries. While this study was undertaken for improving road safety in LMICs, the recommendations and observations identified can be considered relevant and valuable for all countries aiming to improve safety on their roads.

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