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No. 89

Improving Road Safety

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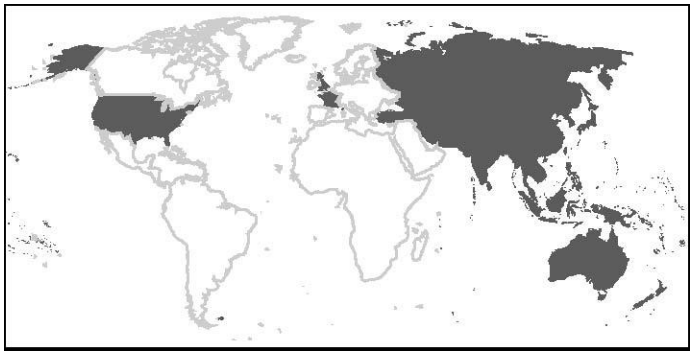

The shaded areas of the map are ESCAP Members and Associate members.

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PREFACE

Member States have pledged to deliver results for all with the adoption of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs). And yet, an estimated 1.35 million road traffic fatalities still occur on roads around the world every year and approximately 50 million victims are seriously injured or disabled for life. Road safety has become one of the most pressing development issues of our times, with its multi-dimensional social and economic consequences.

This global agenda acknowledges the need to act in the light of these tragedies. Within the United Nations SDGs, which aim to "leave no one behind", two targets are set: SDG target 3.6 to halve the number of road fatalities and injuries by 2020 and target 11.2 to provide safe, accessible and affordable sustainable transport for all by 2030. As the United Nations Secretary-General's Special Envoy for Road Safety, I encourage governments, non-governmental organizations, researchers, and – most importantly – all of us citizens to realize that road crashes are not a twist of destiny that strikes some and spares others. Achieving road safety is at the hands of everyone and there are proven solutions.

The best performing countries in terms of the number of road traffic fatalities have established a complete road safety system to manage and prevent road crashes. This comprises a strong regulatory framework with application of the United Nations road safety legal instruments; safe infrastructure which protect all road users; safe vehicles in line with the United Nations regulations; safe road user behavior with an established road safety culture reflected in the UN Vienna Conventions; and effective and comprehensive post-crash care. These components must be implemented with strong national legislation, enforcement, education as well as use of innovation and technology.

Unfortunately, there are many countries and regions around the world which do not have a full or effective system in place to address this growing challenge. The Asia and Pacific region continues to be one of the most affected in regards to the number and rate of road traffic fatalities and serious injuries. I commend the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) for its dedication to improving road safety in this region. This bulletin presents several experiences and practices that have been adopted by some countries in the area and have contributed to reducing the number of road crashes. They are worth studying.

On the global front and thanks to the work of all partners, which have helped us at the national and regional levels, there have been many accomplishments. To build momentum for our individual efforts, let us use the more than 10 United Nations General Assembly resolutions on improving road safety, which call for increased action from all Member States. Also, in 2018, initiated by United Nations Economic Commission for Europe (UNECE) and me, 10 United Nations organizations have established the first UN Road Safety Fund aimed to support the most affected countries in building national road safety systems and to help catalyze more funds. The first formal call for proposals was launched in October 2019, and we expect the most vulnerable countries to benefit from this initiative. Finally, the third Global Ministerial Conference on Road Safety is taking place in Stockholm in February 2020 marking the end of the Decade of Action for Road Safety and blazing our path for the next. This will provide us with even stronger precedence to accelerate action.

While many development issues are intractable, road crashes are not one of them. Solutions exist and must be applied. We should all learn from one another. Join me, UNESCAP and other stakeholders in making our roads safer.

Jean Todt
United Nations Secretary-General's Special Envoy for Road Safety

** On 29 April 2015, Jean Todt was appointed by the Secretary-General of the United Nations as Special Envoy for Road Safety. Mr. Todt is also the President of the Fédération Internationale de l'Automobile since October 2009. This follows a career as a rally driver and in motor sport management, first with Peugeot Talbot Sport, then with Scuderia Ferrari F1 team, before being appointed Chief Executive Officer of Ferrari from 2004 to 2008.*

Editorial Statement

The *Transport and Communication Bulletin for Asia and the Pacific* is a peer-reviewed journal that is published once a year by the Transport Division of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). The *Bulletin* is a medium in which knowledge, experience, ideas, policy options and information on the development of transport infrastructure and services in the Asia-Pacific region is shared. The main objectives to these are to stimulate policy-oriented research and to increase awareness on the policy issues and responses of the transportation industry. The *Bulletin* attempts to widen and deepen the debate on the issues of interest and concern in the transport sector.

Transport plays an integral part in the development of social and economic opportunities. It facilitates the movement of people, goods, labors, resources, product and ideas across regions. Different transport modes and services and the state of domestic and international connectivity can greatly influence the well-being of the people and their own environment. However, as the levels of motorization in Asia and the Pacific continue to increase, it also has resulted in an increase of traffic fatalities and injuries. At the rate of the growing epidemic of traffic accidents, the issue of road safety has become a global development agenda. Managing the transport sector can make a direct and indirect contribution towards the achievements of the SDGs if the three pillars of sustainable development – economic, social and environmental – are integrated into transport policies, planning and operation. Two SDGs targets are relevant to road safety -target 3.6 to halve the number of road fatalities and injuries by 2020 and target 11.2 to provide safe, accessible and affordable sustainable transport for all by 2030.

The current issue of the *Bulletin* focuses on the theme of “Improving Road Safety”. Each of the six papers contribute different interesting aspects of the theme, and include various approaches in improving road safety in a particular context.

The first article by Kassim, Ahmad, Jawi and Ishak provide an overview of testing safety features of cars entering ASEAN market. It also outlines the work of ASEAN NCAP in crating awareness of buyers and improving safety aspects cars by advocating importance of safety features and ensuring their compliance working with countries and manufacturers. ASEAN NCAP has covered 90 percent of the passenger car brands sold in the Southeast Asian market, m0re than 100 ratings have been produced, and 3 road maps has been developed. Continuing with its commitment to contribute to safety, ASEAN NCAP is planning to focus on the safety of motorcycle and motorcyclists in the region.

The second article by Brondum and Kinyanjui, presents the Alliance work in advocating evidence-based action to improve road safety in Asian countries. It includes five good practice cases: resource mobilization and partnerships for sustainability in India; increasing affordability, awareness and use of standard child helmets in Malaysia and the Philippines; strengthening pedestrian safety through legislation in Nepal: and speed reduction and School zone safety in Viet Nam. The paper stresses the need for NGOs and stakeholders in Asia to reposition themselves, articulate their role to the specific challenges and carryout targeted advocacy and capacity building work in order to improve road safety in the region.

The third article by Bhavsar, Tharakan, Rogers, Smith, and Mcinerney discusses two examples of road safety assessment of road section in Karnataka and Gujarat as part of the International Road Assessment Programme (iRAP). The assessment includes safety Star Ratings and cost and benefit estimates for safety treatment options along each road. The result shows investments in infrastructure safety countermeasures implemented in the road section in Karnataka led to a halving in road fatalities on the road. The paper argues that the improvement of safety Star Ratings of road to 3 or higher can greatly improve the safety of road, which can be a good model for other countries to follow.

The fourth article by Cliff, Fleiter, Flieger, Harman, and Murphet presents the Global Road Safety Partnership’s (GRSP) road policing capacity building activities in Asia and outlines some of the key challenges experienced across the region. GRSP capacity building model focuses on police leaders, frontline operational officers and internal police trainers. GRSP encourages all levels of the enforcement agency to understand the importance of strategy to improve road safety outcomes. It also includes an example from the Philippines on strengthening the capacity of police to enhance their speed enforcement capability. The paper argues for the need for enforcement agencies to embrace the

importance of collecting and analyzing own data to guide enforcement activities. Evidence based and data-led enforcement can provide agencies with options for the efficient allocation of limited enforcement resources.

The fifth article by Swamy, Bhakuni and Sinha, analyze the trend of road fatalities and injuries in Ahmedabad. It includes analysis of vulnerable groups such as pedestrians and two-wheelers, highways in urban areas, hot spots in the city where accidents are more prone to occur, and lastly the effect of using video-surveillance to monitor road safety behaviors. The research found that pedestrians remain as the most impacted users, and cars have become the most predominant contributor to fatalities across the city. It also reveals that use of video surveillance has contributed to change in user behaviour. The authors suggest better speed restriction, introduction of more signals, improvement on the pedestrian facilities and focusing on public transportation as some of the meatuses to reduce accidents.

The sixth article by Alam presents a causal analysis of road traffic accidents and related deaths with other macroeconomic indicators in India. The analysis shows negative relation between public expenditure on health services and numbers of fatalities in road crashes. The paper indicates significant variation among States in number of road accidents and number of deaths per accident and reveals the need for post-accident health care facilities in most of the Indian states. The papers suggest to pay special attention to safety of national highways passing through rural areas. It stresses the need to increase in public expenditure for post-accident health and improvement of public transport to save lives on Indian roads.

The *Bulletin* encourages analytical discussion on topics that are at the forefront of transport development in the region, as well as policy analysis and best practices. Articles should be based on original research and have an in-depth analytical process. Articles should be empirically based and emphasize policy implication emerging from such analysis. Book reviews are also welcomed.

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TRANSPORT AND COMMUNICATIONS BULLETIN
FOR ASIA AND THE PACIFIC
NO. 89

CONTENTS

ASEAN NCAP'S SUCCESS AND CHALLENGES IN PROMOTING SAFER VEHICLES IN THE ESCAP REGION

Khairil Anwar Abu Kassim, Ahmad, Jawi and Ishak

ABSTRACT

Starting from 2011, ASEAN NCAP has been mandated to carry out crash tests on new cars in the ESCAP region, particularly Southeast Asia. With a total population of over 630 million, the 10 countries comprising ASEAN have seen passenger vehicle sales reach over three million units. To date, 90 percent of the vehicles sold in ASEAN market have been tested by ASEAN NCAP. Their safety aspects have been greatly improved over time. But aside from the safety of car occupants, ASEAN NCAP is also concerned with the safety of vulnerable road users. In November 2018, ASEAN NCAP announced its latest road map which focuses on the safety of motorcyclists in the region. ASEAN NCAP's efforts have also been recognized by the Malaysian government, as of next year, all car dealers are to showcase the star rating issued by ASEAN NCAP on the car's front windshield and side mirror in all showroom and sales centres in Malaysia. This is to educate buyers to choose the models that give priority to the best rating. The current paper shall provide an overview of the results produced by ASEAN NCAP, including its success and challenges to elevate the safety standards of passenger vehicles in the Southeast Asian market. In addition, the last section will describe ASEAN NCAP road map which guides its journey toward achieving SDG targets 3.6 and 11.2.

Keywords: ASEAN NCAP, Safety Star Rating, MIROS PC3, UN Decade of Action, SDG targets

1. INTRODUCTION

The New Car Assessment programme for Southeast Asian Countries or ASEAN NCAP was established in December 2011 through a joint effort by Global NCAP and Malaysia's Institute of Road Safety Research (MIROS). Similar to other NCAPs operating in different parts of the world, namely the United States, Latin America, Europe and Australia/New Zealand, ASEAN NCAP's primary motivations are to improve motor vehicle safety standards, build a market for safer vehicles and raise consumer awareness (GNCAP, 2011). Such objectives are in line with the UN Decade of Action for Road Safety 2011–2020, Pillar 3 Safer Vehicle.

Since its launch, ASEAN NCAP has performed a series of crash tests on new cars entering the ESCAP region particularly Southeast Asia to ensure safe design standards in crashworthiness and crash compatibility for various brands and models before awarding them with the safety star rating. Over a span of 8 years, ASEAN NCAP has tested almost 90 percent of the passenger car brands sold in the Southeast Asian market. More than 100 ratings have been produced, and 3 road maps have been introduced since ASEAN NCAP was first unveiled (ASEAN NCAP, 2019)

Due to ASEAN NCAP's efforts, the safety aspects of passenger vehicles in the ESCAP region particularly in Southeast Asia have clearly witnessed tremendous improvements as opposed to in the past. For instance, in 2008, a certain passenger car model was merely fitted with a single airbag. Today, however, the same model is sold in ASEAN countries with 7 airbags and Electronic Stability Control (Khairil Anwar, 2018). Aside from passenger car occupants, ASEAN NCAP is also concerned with the safety of vulnerable road users (VRUs) especially motorcyclists. Hence, most new models offered to potential buyers in Southeast Asia are now equipped with the blind spot technology to reduce the risk of collision with motorcyclists (ASEAN NCAP, 2018).

The current paper aims to provide an overview of the results produced by ASEAN NCAP, including its success and challenges to elevate the safety standards of passenger vehicles in the Southeast Asian market. In addition, the last section will describe ASEAN NCAP road map which guides its journey

toward achieving SDG target 3.6 on halving the number of global deaths and injuries from road traffic accidents; and SDG target 11.2 on providing access to safe, affordable, accessible and sustainable transport systems as well as improve road safety for all.

2. BACKGROUND INFORMATION OF THE NEW CAR ASSESSMENT PROGRAMMES

In 1979, the National Highway Traffic Safety Administration (NHTSA) started the New Car Assessment Programme (NCAP) to encourage buyers to demand safer vehicles and auto makers to supply them. NHTSA's first standardized frontal crash test was performed on 21 May 1979, and the results were made public five months later. The agency established a frontal impact test protocol based on Federal Motor Vehicle Safety Standard 208 ("Occupant Crash Protection") or FMVSS No. 208 (NHTSA, 2015).

Aside from NHTSA, an independent non-profit organization, the IIHS, was also formed. Headquartered in Arlington, Virginia, IIHS strives to reduce the number of motor vehicle traffic collisions, and the rate of injuries and amount of property damage in such crashes. In addition, the institute carries out research and gives ratings for top-selling passenger vehicles as well as for certain consumer products such as the child restraint systems (Lam, 2014).

IIHS's frontal crash test, which began in 1995, differs from that of the NHTSA programme in that the former performs offset test. In the offset test, 40 percent of the front of the vehicle is exposed to an impact with a deformable barrier at approximately 65 km/h. Further, IIHS evaluates six individual categories, awarding each a "Good", "Acceptable", "Marginal", or "Poor" rating before providing the vehicle's overall frontal impact rating (Lam, 2014).

Across the Atlantic, the European New Car Assessment Programme (Euro NCAP) was founded in 1997 and was based in Leuven, Belgium. With its slogan "For Safer Cars", the programme gained the recognition of several European governments, in addition to the support by the European Union.

Euro NCAP's frontal tests are performed at 64 km/h into an offset deformable barrier. Additionally, Euro NCAP's side impact tests are conducted at 50 km/h, while the side impact pole test is performed at 32 km/h. The pedestrian safety tests, on the other hand, are carried out at 40 km/h (Euro NCAP, 2015).

Meanwhile, the Australasian New Car Assessment Programme (ANCAP) was launched in 1993 to carry out the crash testing of passenger vehicles sold in Australia and New Zealand and disseminating results to consumers. To date, ANCAP has published crash test results for thousands of passenger and light commercial vehicles. The tested vehicles are awarded ANCAP safety rating between 1- and 5-Star. To achieve the maximum 5-Star safety rating, a vehicle must reach the highest standards in all tests and include advanced safety assist technologies (GNCAP, 2017).

Established in 2010, the Latin American & Caribbean New Car Assessment Programme (Latin NCAP), on the other hand, is backed by the Inter-American Development Bank (IADB) following the Euro NCAP and other similar programmes around the world. Latin NCAP, however, focuses on the active and passive safety features of new cars sold in Latin America and the Caribbean (GNCAP, 2017).

Finally, the latest addition to the NCAP family is the New Car Assessment Programme for Southeast Asia (ASEAN NCAP). Unveiled in December 2011, the automobile safety rating programme was jointly established by Malaysia Institute of Road Safety Research (MIROS) and Global NCAP. With the existence of a new car assessment programme which exclusively focuses on the Southeast Asian market (see Figure 1), safety aspects of new passenger cars in the region immediately experienced positive changes (Khairil Anwar, 2018).

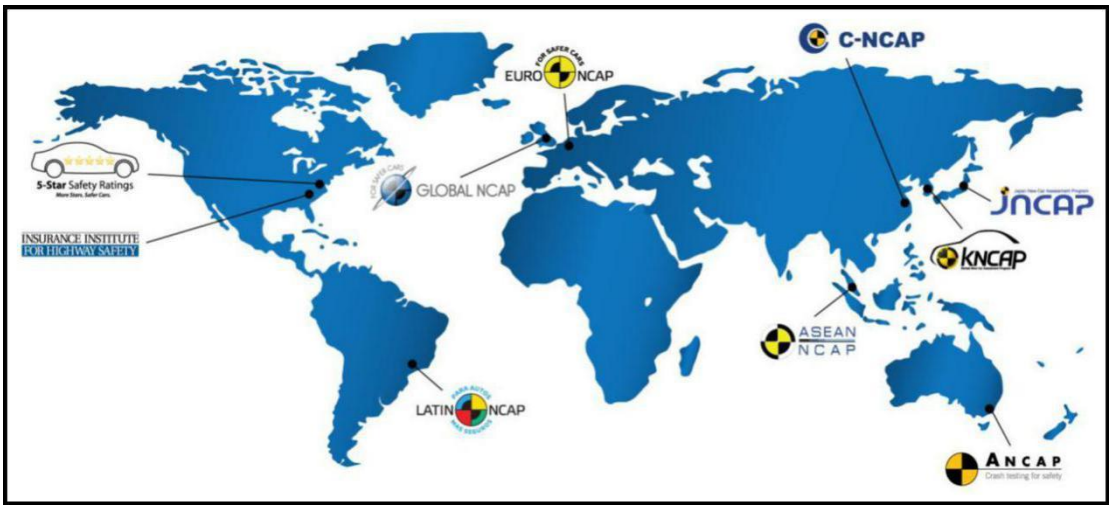

Figure 1. New Car Assessment Programmes (NCAPs) in different parts of the world

3. SAFER VEHICLES AS THE KEY TO SAFER ASEAN ROADS

The Association of South East Asian Nations (ASEAN) comprises Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam. With a combined total population of over 630 million, the 10 ASEAN countries have seen passenger vehicle sales soar to over three million units since 2012 (Yamakawa, 2018). Among the member nations, Thailand, Malaysia and Indonesia have emerged as the largest car manufacturers with 90 percent Total Industry Production (TIP) as well as 86 percent Total Industry Volume (TIV) (Deutsche Bank Research, 2011).

Unfortunately, road traffic fatalities involving car occupants, motorcyclists, pedestrians, and cyclists have remained a cause of major concern around the world, including in Southeast Asia. In its Global Status Report on Road Safety 2018, the World Health Organization (WHO) estimates that 1.35 million people perish each year due to road traffic accidents. In another report for 2013, Thailand was placed at the top of the most dangerous roads list with a death rate of 36.2 per 100,000 population whereas Malaysia registered a death rate of nearly 23 per 100,000 population. Indonesia and the Philippines have also made the list by registering 15 and 11 death rates respectively (WHO, 2013).

Recent reports also suggest that more than 50 percent of all road traffic fatalities involve VRUs, with motorcyclists accounting for more than half of the number in four ASEAN countries, namely Cambodia, Lao People's Democratic Republic, Malaysia and Thailand. The economic consequences of motor vehicle crashes have also been estimated to cost most countries around 3 percent of their gross domestic product (WHO, 2018).

To improve road safety and curb traffic fatalities, the Global Plan for the Decade of Action for Road Safety 2011-2020 was formulated by giving due attention to five “pillars”, namely (a) building road safety management capacity, (b) improving the safety of road infrastructure, (c) further developing the safety of vehicles, (d) enhancing the behaviour of road users, and (e) improving emergency and other post-crash services (WHO, 2013).

Among its activities, the Decade of Action clearly calls for improved vehicle safety technologies for both passive and active safety through a combination of harmonization of relevant global standards, consumer information schemes and incentives to accelerate the use of new technologies.

Hence, safer vehicles play a vital role in alleviating the risk of crashes and reducing the likelihood of serious injury. There are several UN regulations on vehicle safety that, if applied to countries’ manufacturing and production standards, would potentially reduce road deaths. These include demanding vehicle manufacturers to meet front and side impact regulations, to install electronic stability control to prevent over-steering and to ensure fitment of airbags and seat-belts in all vehicles (WHO, 2018).

Regardless, before the emergence of ASEAN NCAP, the safety of passenger vehicles which populated ASEAN roads have not been duly emphasized. For example, fitment of the airbag was not mandatory whereby the ratio of the vehicles installed with airbag compared to the vehicles without was 20:80. The inception of ASEAN NCAP was therefore regarded by many as a step in the right direction to create a paradigm shift in the region's automotive ecosystem (Zulhaidi et al., 2013).

4. ASEAN NCAP TEST RESULTS

In January 2013, ASEAN NCAP announced the programme's First Phase results involving eight cars from seven different crash-test models. All these models are sold in the Southeast Asia region, and they include Ford Fiesta, Honda City, Toyota Vios, Perodua Myvi, Hyundai i10, Proton Saga (no longer in production since January 2013) and Proton Saga FLX+ (currently known as Saga SV).

At this point, the rating scheme was separated into two assessments encompassing the star-rating for Adult Occupant Protection (AOP) and the percentage-based rating for Child Occupant Protection (COP). Ford Fiesta managed to reach the highest standard (5-Star) among the tested models with overall AOP score of 15.73. Honda City came in second with 15.44 points (5-Star range, which was valid for the variant with ESC).

In the First Phase, the lowest AOP score was obtained by the Proton Saga with 4.3 points, enabling it to be awarded 1-Star rating. Such a low score was mainly attributed to excessive head injury level sustained by the Front Passenger. Due to absence of frontal airbag and seatbelt pre-tensioner aside from excessive seat movement, the Front Passenger's head impacted the instrument panel. ASEAN NCAP, nevertheless, was notified that the model would no longer be in production effective from January 2013 and was soon to be replaced. A reconciliation test was conducted on the new Proton Saga FLX+ model at the end of Phase I and it managed to attain 3-Star (Khairil Anwar, 2018).

Results of Phase I tests showed a significant gap between the best and the worst; with Ford Fiesta obtaining 5-Star rating with the highest overall AOP score (15.73) while Proton Saga FLX reached 1-Star rating with the lowest AOP score of 4.3. As for COP, Honda City achieved the highest percentage (81.2 percent), followed by Ford Fiesta (66 percent) while the remaining cars obtained about 50 percent each (Khairil Anwar, 2018).

In summary, seven popular models had been successfully crash tested and assessed in ASEAN NCAP's First Phase. The official results were then posted on ASEAN NCAP website (www.aseancap.org) to be retrieved by the general public. Such an announcement has been the prime objective of NCAP as these test results are hoped to raise awareness about the safety ratings of car models available in the ASEAN market. ASEAN NCAP believes this would lead to consumers being able to make an informed choice in regard to purchasing a brand-new car.

The ASEAN NCAP Star Rating results for Phase I crash tests are as follows:

Vehicle tested	**Star rating**
Ford Fiesta	★★★★★
Honda City	★★★★★
Toyota Vios	★★★★★
Nissan March	★★★★★
Perodua Myvi	★★★★★
Hyundai i10	★★★★★
Proton Saga	★★★★★

Source: www.aseancap.org

While Phase I of ASEAN NCAP's assessment comprised eight test models, Phases II and III each featured 11 test vehicles. Phase II results were announced on 29 August 2013 at MIROS in Kajang, Selangor, in the presence of all ASEAN NCAP steering and technical committee members.

The ASEAN NCAP Star Rating results for Phase II crash tests are as follows:

Vehicle tested	Star rating
Toyota Prius	★★★★★
Honda Civic	★★★★★
Subaru XV	★★★★★
Suzuki Swift	★★★★★
Mazda 2	★★★★★
Mitsubishi Mirage	★★★★★
Toyota Avanza	★★★★★
Perodua Alza	★★★★★
Nissan Almera	★★★★★
Daihatsu Xenia	★★★★★
Misubishi Pajero Sport	★★★★★

Source: www.aseancap.org

At the launch of the Phase II results, Australasian NCAP (ANCAP) noted that "Since the release of Phase I results earlier this year, ASEAN NCAP have not only conducted another round of successful tests, they have also developed strong relationships with manufacturers, approved another lab for testing within the region, and expanded the scope of their test programme to include larger people movers and SUVs. The benefits we have seen across Australia and New Zealand as a result of ANCAP testing are sure to be seen across the ASEAN as a result of their growing test programme," (Automotive World, 2013).

Following this, ASEAN NCAP Phase III test results were announced during two parallel sessions on 5 May 2014, namely the Results Launching with Consumers' Viewing at Philea Resort & Spa in Malaysia and the 2014 Global NCAP Forum in Australia. A total of 11 popular car models had been tested in Phase III.

The ASEAN NCAP Star Rating results for Phase III crash tests are as follows:

Vehicle tested	Star rating
Honda CR-V	★★★★★
Proton Prevé	★★★★★
Toyota Corolla Altis 2.0	★★★★★
Chevrolet Colorado	★★★★★
Toyota Corolla Altis	★★★★★
Volkswagen Polo	★★★★★
Kia Picanto (6 airbags)	★★★★★
Peugeot 208	★★★★★
Chevrolet Sonic	★★★★★
Isuzu D-Max	★★★★★
Kia Picanto Non- Airbag	★★★★★

Source: www.aseancap.org

- ASEAN NCAP's first 0-Star was awarded to the Kia Picanto brought from Thailand. The car did not come with any airbag.

In 2014, ASEAN NCAP assessed another 12 models with 14 variants. The summary of the achievements is shown below. The Q3 and Q4 2014 tests involved the Tata Vista, Honda City (2014), Perodua Axia, Honda Jazz (2014), Proton Iriz and Nissan Teana. Results of Q3 and Q4 2014 are highlighted in the following table:

Vehicle tested	AOP	COP
Tata Vista	★★★★★	★★★★★
Honda City (2014)	★★★★★ ★★★★★	★★★★★
Perodua Axia	★★★★★	★★★★★
Honda Jazz (2014)	★★★★★ ★★★★★	★★★★★
Proton Iriz	★★★★★	★★★★★
Nissan Teana	★★★★★	★★★★★

Source: www.aseancap.org

Six new manufacturers were involved in ASEAN NCAP in Phases 3 and 3+, with the Nissan Teana recording the highest achievement in ASEAN NCAP's tests by scoring 16/16 for frontal test. Its COP also reached 5-Star for the first time in history.

In addition, the Perodua Axia, the compact car from Malaysia reached 4-Star and was the most affordable 4-Star car in ASEAN with the price of USD 8,000 whereas the Proton Iriz with standard ESC fitment was the most affordable 5-Star car in ASEAN.

Further, the first left-hand drive (LHD) vehicle tested in ASEAN NCAP was Honda CR-V, produced in Thailand for the Philippines and Viet Nam market. Aside from the results launching of Phase III held in Melbourne and Melaka, ASEAN NCAP also launched several results during ASEAN NCAP Grand Prix 2014 and the final result for Nissan Teana during ASEAN Automobile Safety Forum 002 in Bangkok, Thailand (Khairil Anwar, 2018).

As for 2015, the Q1 and Q2 tests involved the Perodua Myvi (2015) and Suzuki S-Cross. It should also be noted that starting from January of the year, ASEAN NCAP had introduced the side impact test (UN R95) as a new pre-requisite for 3-Star and above. Also, COP was presented in star-rating form. Results of Q1 and Q2 2015 are highlighted in the table below:

Vehicle tested	AOP	COP
Perodua Myvi (2015)	★★★★★	★★★★★
Suzuki S-Cross	★★★★★	★★★★★

Source: www.aseancap.org

Additionally, the Q3 and Q4 tests in 2015 included Mitsubishi Triton, Honda HR-V, Toyota Rush, Great Wall Haval M4, Mitsubishi Triton (High Variant), Datsun GO, Daihatsu Ayla (non-airbag), Daihatsu Ayla, Toyota Agya, Toyota Hilux and Ford Ranger. Results of ASEAN NCAP's Q3 and Q4 2015 tests are indicated in the following table:

Vehicle tested	AOP	COP
Mitsubishi Triton	★★★★★	★★★★★
Honda HR-V	★★★★★	★★★★★
Toyota Rush	★★★★★	★★★★★
Great Wall Haval M4	★★★★★	★★★★★
Mitsubishi Triton (High Variant)	★★★★★	★★★★★
Datsun GO	★★★★★	★★★★★
Daihatsu Ayla (Non-Airbag)	★★★★★	★★★★★
Daihatsu Ayla	★★★★★	★★★★★
Toyota Agya	★★★★★	★★★★★
Toyota Hilux	★★★★★	★★★★★
Ford Ranger	★★★★★	★★★★★

Source: www.aseancap.org

Afterwards in 2016, ASEAN NCAP's Q1 and Q2 tests featured Ford Everest, Hyundai i10 (2015), Nissan Grand Livina, Toyota Innova, Toyota BR-V, Volkswagen Vento, Nissan X-Trail, Suzuki Ertiga, Suzuki Ciaz and Kia Morning. Our Q1 and Q2 2016 results are as shown below:

Vehicle tested	AOP	COP
Ford Everest	★★★★★	★★★★★
Hyundai i10 (2015)	★★★★★	★★★★★
Nissan Grand Livina	★★★★★	★★★★★
Toyota Innova	★★★★★	★★★★★
Toyota BR-V	★★★★★	★★★★★
Volkswagen Vento	★★★★★	★★★★★
Nissan X-Trail	★★★★★	★★★★★
Suzuki Ertiga	★★★★★	★★★★★
Suzuki Ciaz	★★★★★	★★★★★
Kia Morning	★★★★★	★★★★★

Source: www.aseancap.org

The crash test videos can be accessed on ASEAN NCAP Youtube channel. Additionally, ASEAN NCAP has also published "Safer Cars for ASEAN Region: A Compilation of ASEAN NCAP Test Results 2016 Update". The publication encompasses the test results from Phase I in 2012 to Q1 & Q2 tests in 2016.

Later, on 19 December 2017, ASEAN NCAP announced four new crash test results for the fourth quarter of 2017 which included:

Vehicle tested	Star rating
Perodua Myvi	★★★★★
Toyota Vios	★★★★★
Chery Transcab	★★★★★
Suzuki Carry	★★★★★

Source: www.aseancap.org

- The All-New Perodua Myvi moved up one level by obtaining 5-Stars with an overall score of 88.27 points. From this score the Myvi obtained 45.43 points for AOP, 22.01 points for COP and 20.83 points for SATs.
- The Toyota Vios overall score was 81.63 points thus falling into the 5-Star category. The overall score can be broken down according to each domain with 44.70 points for AOP, 21.66 points for the COP and 15.28 points for SATs category.
- The Chery Transcab was awarded 0-Star with an overall score of 17.04 points. This light commercial vehicle's points were based on its AOP domain, specifically from its side impact score.
- The Suzuki Carry, a light commercial vehicle with a single cab, scored low under the ASEAN NCAP new protocol. The model received an overall score of 17.14 points, which was based on its frontal offset assessment. This score placed the Carry with 0-Star rating.

ASEAN NCAP Q2 2018 crash tests, in addition, featured three models, namely Hyundai IONIQ Hybrid, Toyota Rush and Toyota C-HR. The overview of the results are as follows:

Vehicle tested	Star rating
Hyundai IONIQ Hybrid	★★★★★
Toyota Rush	★★★★★
Toyota C-HR	★★★★★

Source: www.aseancap.org

- The Hyundai IONIQ Hybrid was awarded with 5-Star rating by reaching a total score of 91.98 points. The hatchback's score was accumulated from the three assessed domains with 46.34 points for AOP, 21.48 points for COP and 24.17 points for SATs.

- The new Toyota Rush was eligible for 5-Star ASEAN NCAP rating with an overall score of 84.03 points. The SUV obtained this accumulated score from 43.25 points for AOP, 21.33 points for COP and 19.44 points for SATs categories
- The Toyota C-HR reached an overall score of 91.31 points with 5-Star rating. The model's result was accumulated from AOP at 49.72 points, COP at 20.86 points and SATs with 20.73 points

Finally, the latest ASEAN NCAP result features the new Toyota Majesty/Granvia, which reached 5-Star rating with an accumulated score of 89.51 points. The score for each of the category the MPV was assessed included 46.31 points for AOP, 22.93 points for COP and 20.27 points for SATs (ASEAN NCAP, 2019).

5. ASEAN NCAP'S SUCCESS

In line with SDG targets 3.6 and 11.2, the introduction of ASEAN NCAP has made the issue of motor vehicle safety more prominent in the Southeast Asian automotive sphere. More automobile manufacturers have, as a result, displayed interest to include ASEAN NCAP ratings in their product brochures. Among the successes of the ASEAN NCAP to be elaborated here include introducing the Affordable Safety concept, gaining recognition and support from the government in promoting safer cars, enhancing cooperation among ASEAN automotive fraternity, emphasizing the use of advanced technologies to reduce road crashes, and promoting ESC as a standard in Malaysia and ASEAN.

5.1 Introducing the Affordable Safety Concept

To date, ASEAN NCAP has assessed more than 80 new passenger vehicles comprising 25 brands, therefore covering 90 percent of the market share. In the context of the Southeast Asia region, 'safer cars' are those which have obtained ASEAN NCAP score of at least 4 Stars compared with the ones registered on the road upon successfully obtaining VTA from the road transport department in their respective countries (Zulhaidi et al., 2013).

In 2014, ASEAN NCAP presented the Affordable Safety concept in a bid to ensure even the most economical cars could meet ASEAN NCAP basic standards. As a consequence, two models from Malaysia's national car makers, namely Proton and Perodua gained the advantage from such a concept.

The Proton Iriz which was awarded 5-Star for AOP (14.07/16.00 points) and 4-Star for COP (82 percent) is priced as low as RM 41,520 (USD 10,278). On the other hand, the Perodua Axia which obtained 4-Star for AOP (12.91/16.00 points) and 4-Star for COP (71 percent) is sold from as low as RM 24,437 (USD 6,054). These models embody ASEAN NCAP's slogan that 'Safety is Affordable' (Khairil Anwar, 2018).

Additionally, through both Vehicle Type Approval (VTA) obtained from the Road Transport Department and the assessments performed by ASEAN NCAP, the latter has been able to raise the safety specifications particularly for the base model which include:

- All cars in the new car market are now fitted with airbag. Some even boast dual airbags (DAB & PAB).
- Electronic Stability Control (ESC) is fitted in affordable cars such as Proton Iriz. This also has made Anti-Lock Braking System (ABS) seem out-dated.
- More child safety features, namely ISOFIX and top tether are installed by OEMs.
- Safety package as a whole is no longer a luxury and is within majority of users' reach.
- Proton and Perodua have not significantly increased their price although their cars come with reinforced body structure and safety equipment.
- Perodua Axia is acknowledged as the most affordable car in Malaysia with 4-Star for AOP.
- Proton Iriz is the most affordable 5-Star for AOP car in Malaysia with ESC being a standard across all variants.

5.2 Gaining Government Recognition and Support in Promoting Safer Cars

With the support of the Ministry of Domestic Trade and Consumer Affairs Malaysia, ASEAN NCAP has introduced the ASEAN NCAP Labelling Compliance Guideline in order to reduce potential confusion on the information provided by the new car assessment programme and encourage the dissemination of safety information to consumers. This guideline shall apply to all cars assessed by ASEAN NCAP and those which have yet to be tested. At the same time, the Malaysia Consumerism Standard Division has agreed to organize awareness campaigns to educate the public about the labeling system and safety rating based on the safety features of the vehicles they own (Paultan.org, 2019).

Further, beginning 1 March 2020, passenger vehicles being displayed in all sales and showroom centres, hypermarkets, etc are compelled to present their respective safety rating as endorsed by ASEAN NCAP. The label will definitely add value to a certain model and attract interest of buyers for its recognized safety standards, aside from the information on vehicle specifications and QR codes. In addition, KPDNHEP will use the Trade Descriptions Act (APD) 2011 to enforce the guideline (KPDNHEP, 2019).

Although the collaboration is between the Ministry of Domestic Trade and Consumer Affairs Malaysia and ASEAN NCAP, the guideline can also be applied to other ASEAN countries.

5.3 Enhancing Cooperation Among ASEAN Automotive Fraternity

Various collaborators, governmental institutions, contributors and manufacturers have come together in aid of the new car assessment programme in Southeast Asia. To date, ASEAN NCAP has received strong support from Automobile Associations of Malaysia (AAM), the Philippines (AAP), Singapore (AAS), Cambodia, and Thailand (RAAT), whereby they are involved in the ASEAN NCAP Steering Committee. ASEAN NCAP has also collaborated with such associations in the dissemination of information regarding safer cars as well as educating consumers in their respective countries (Zulhaidi, et al., 2015).

In addition, a Technical Committee to lend assistance in crash test − comprising The Sirindhorn International Thai-German Graduate School of Engineering, University of the Philippines National Centre for Transportation Studies, Institut Teknologi Bandung, Australasian NCAP, Euro NCAP, and Japan NCAP − has also been formed.

More recently, ASEAN NCAP has launched the ASEAN NCAP Collaborative Holistic Research (ANCHOR) Project as part of its effort to elevate vehicle safety in the Southeast Asia. ANCHOR shall feature a collaborative research project between ASEAN NCAP, Universiti Teknologi PETRONAS (UTP), Haluoleo University, Indonesia, Universiti Teknologi Malaysia (UTM) and International Islamic University Malaysia (IIUM, with the aim of gathering information to build a database for safer riding experiences among motorcyclists in the region, particularly for Malaysia and Indonesia (ASEAN NCAP, 2019).

5.4 Emphasizing the Use of Advanced Technologies to Reduce Road Crashes

Since the establishment of ASEAN NCAP nearly 8 years ago, more technologies that could help reduce road accidents have been offered by car manufacturers to consumers in Southeast Asia. In previous time, the airbag was considered a safety feature only available to expensive car owners. Today it has become a standard fitment where most cars are equipped with at least 2 airbags. ESC and ABS have also become a necessity for drivers in the ASEAN region.

Looking ahead, ASEAN NCAP aims to promote various technologies that can assist drivers such as advanced rear-view mirror, blind spot technology, and auto high beam. In addition, ASEAN NCAP shall give greater attention on the safety of two-wheeler riders in Southeast Asia and shall encourage implementation of autonomous emergency braking system (AEB) as well as anti-lock brakes (ABS) for motorcycles. In the foreseeable future, ASEAN NCAP also plans to cover other prominent safety issues such as pedestrian crash compatibility and also autonomous driving (ASEAN NCAP, 2019).

5.5 Promoting ESC as a Standard in Malaysia and ASEAN

Aside from performing crash tests in accordance with the United Nation Regulations 94 and 95, ASEAN NCAP has constantly stressed on the use of safety assist technologies that can reduce the number of road traffic collisions.

Hence, given the substantiated benefits of ESC in preventing single-vehicle, run-off-road crashes, especially those with more serious outcomes, the implementation of ESC has been accelerated to cover the full range of passenger vehicles in the Malaysian automobile market through the efforts carried out by both Malaysia's Institute of Road Safety Research (MIROS) and ASEAN NCAP.

Subsequently, MIROS took the initiative to recommend and propose the use of ESC in passenger vehicles to the Malaysian government, through the Ministry of Transport, to reduce road traffic fatalities in the country. The recommendations were also made in line with the objectives of the UN Decade of Action for Road Safety 2011-2020.

Following such a recommendation, Malaysia's Minister of Transport made the timely announcement that all new models of passenger cars marketed in the country must be equipped with the safety system by June 2018 (Paultan.org, 2016).

Describing ESC as the most cost-effective life-saving device at present, the Minister of Transport also stated that the use of ESC in Malaysia, with its tropical climate and heavy rain, will be able to curb road accidents involving passenger vehicles on slippery roads (Todayonline, 2016). This is in line with the findings by the Royal Malaysia Police that more than 45 percent of fatal accidents in Malaysia are caused by loss of vehicle control.

In terms of the potential increase in the cost of vehicles as a result of such a ruling, the Malaysian government believes the increase to be small enough for carmakers to absorb. While ESC has been standard safety equipment in premium cars, the system is being passed on to the masses and can be found in more affordable medium and small vehicles (Carlist.my, 2016).

Although at present only Malaysia has made ESC mandatory by law in the region, ASEAN NCAP has updated its test protocol in 2017 whereby vehicles that do not offer ESC as standard across its range in all ASEAN countries will only be granted a maximum rating of 2 Stars, regardless of their performance in the crash test (Khairil Anwar, 2018).

6. CHALLENGES

Success in elevating the safety standards of passenger vehicles in Southeast Asia does not come by easily. As such, ASEAN NCAP has been faced with numerous challenges in its quest to build a market for safer vehicles and raise consumer awareness. The key challenges to ASEAN NCAP shall be discussed below.

6.1 Test Spectrum and Adoption of Domestic Values

Subject to funding and availability of resources, ASEAN NCAP plans to introduce more comprehensive crash procedures in the near future. Currently, frameworks are being put in place to include other configurations including pole crash tests in the upcoming stages. Furthermore, there have been suggestions for ASEAN NCAP to adopt domestic road safety issues in its safety pillars such as to include motorcycle- and pedestrian-related assessments in order to represent the most vulnerable road user groups in the Southeast Asia region (Zulhaidi et al., 2015).

6.2 Language Barrier

ASEAN NCAP programme has been set up to spread the message that vehicle safety in Southeast Asia is affordable. Regardless, its assessment results as well as the ASEAN NCAP star rating are presented in the English language and therefore, may not be easily understood by the whole ASEAN population due to language differences (Zulhaidi et al., 2015). It is therefore hoped that various parties, whether responsible agencies or non-governmental organizations, will be able to share the information provided

by ASEAN NCAP in their respective languages through the use of traditional and new media technologies.

6.3 Budgetary Constraint

ASEAN NCAP is currently funded by both MIROS and Global NCAP. In addition, the programme has also received non-monetary support from various agencies, technical partners and road safety initiatives from around the world. In ensuring the sustainability and expansion of progressive tests in addition to effective dissemination of information, ASEAN NCAP is seeking more assistance be it in monetary or non-monetary form (Zulhaidi et al., 2015).

7. ASEAN NCAP ROAD MAP 2021 - 2025

Starting in September 2017, ASEAN NCAP has organized several brainstorming sessions with industry players in ASEAN, its steering and technical committee members, academics as well as non-governmental organizations in a bid to understand the most recent road safety issues as well as the readiness of passenger vehicle safety latest technology in the region. In addition, the ASEAN NCAP Collaborative Holistic Research (ANCHOR) has also been initiated to support the latest rating road map, ASEAN NCAP Road Map 2021 - 2025.

Upon deliberation of all the proposals, ASEAN NCAP has decided that its Road Map 2021 - 2025 shall feature 4 pillars. Aside from adult occupant protection (AOP), child occupant protection (COP) and safety assist (SA), motorcycle safety will also be included in ASEAN NCAP's upcoming assessment. Further, for each of the pillars, there shall be additional statements and improvements to the previous rating systems. For example, under COP, ASEAN NCAP Road Map 2021 - 2025 shall include tertiary safety for a child passenger, namely child presence detection in an effort to reduce the cases of a child being left unaccompanied in the car.

The new road map shall also be emphasizing auto emergency braking (AEB) which is a feature to alert drivers to an imminent crash. ASEAN NCAP believes that such technology is important and has been well-received by most car manufacturers. ASEAN NCAP shall also place greater attention to AEB City and Inter-Urban. Nevertheless, ASEAN NCAP has decided to delay the introduction to AEB Pedestrian, albeit having the potential to reduce pedestrian fatalities, until sufficient data is obtained from various studies.

Rear occupant protection shall also be given a close attention in the road map, whereby a total of 50 percent will be rewarded for seat-belt reminder (SBR) rear occupant detection. Such a decision provides evidence that ASEAN NCAP will be focusing on the use of seat-belts as the primary protection for car occupants. Finally, ASEAN NCAP shall also be rewarding points under SA for advanced SAT with OEMs being able to select any technology that is suitable to reduce road traffic casualties. As such, car manufacturers are encouraged to introduce any technology that can benefit road users and help prevent crashes.

To underline ASEAN NCAP's unwavering commitment to the safety of motorcyclists in Southeast Asia, the road map shall also include a new pillar, namely motorcyclist safety. The main technology under this pillar is blind spot technology comprising blind spot detection (for 5-Star level), and blind spot visualization (for 5-Star level). Other technologies such as advanced rear-view mirror, auto high beam, and pedestrian protection have also been included in an attempt to further improve the safety of two-wheeler riders in the ASEAN region.

Finally, it is hoped that the development of the new road map will produce more encouraging results for the betterment of road safety in the ESCAP region in general.

8. CONCLUSION

ASEAN NCAP has assessed more than 80 passenger vehicles comprising 25 brands in order to meet its primary objective to provide consumers in the Southeast Asia region with information pertaining to new car safety ratings in a systematic and comprehensible manner and acknowledge efforts of manufacturers in producing safer cars beyond the current legislation. At the same time, more than 100 ratings have been produced with 3 road maps being introduced.

Since ASEAN NCAP's inaugural crash test was conducted in MIROS crash test facility the PC3 in May 2012, several original equipment manufacturers (OEMs) including Proton, Perodua, Volvo, Toyota, Honda, Ford, Nissan, Hyundai, Mitsubishi as well as other renowned brands have stepped forward in a show of support for this new car assessment programme. In addition, the Malaysia Consumerism Standard Division has also agreed to organize awareness campaigns to educate the public about ASEAN NCAP’s labeling system and rating based on the safety features of the vehicles they own.

As a consequence, the market for safer cars and consumer awareness in the ASEAN region can now be seen clearly. For example, in 2008, a certain car model was only equipped with a single airbag option. But since ASEAN NCAP came into play, the same model is now sold throughout ASEAN with 7 airbags and ESC. As such, laws and programmes including NCAPs are an important means to ensure improved levels of passenger vehicle safety in certain regions. Although there are still some stubborn car manufacturers in Southeast Asia, their number is quite small with only 1 percent.

In November 2018, ASEAN NCAP announced its Road Map 2021-2025 which aims to better protect motorcyclists in the region, as 70 percent of road fatalities in Southeast Asia revolves around two-wheelers. To this end, most cars sold in ASEAN shall be equipped with blind spot technology. Additionally, ASEAN NCAP's latest road map will also place greater emphasis on the safety assist technologies pillar.

Over a period of less than a decade, ASEAN NCAP has covered 90 percent of the market share for new cars in Southeast Asia. From this, 90 percent of the assessed vehicles have reached 4-Stars and above. With such noteworthy results, ASEAN NCAP has proved its unyielding commitment toward meeting SDG targets 3.6 and 11.2.

REFERENCES

ASEAN NCAP (2012). *Assessment protocol and biomechanical limits (version 1.0)*. New Car Assessment programme for Southeast Asian Countries (ASEAN NCAP), Kuala Lumpur, Malaysia.

ASEAN NCAP (2013). *Phase 1 Official Result Handbook*, published by ASEAN NCAP.

ASEAN NCAP (2018). *ASEAN NCAP ROAD MAP 2021-2025*, MIROS, Malaysia [Online]. Available from: http://www.aseancap.org/v2/wp-content/uploads/2019/01/ASEAN-NCAP-ROADMAP-2021-2025.pdf

ASEAN NCAP (2019). *Result Release for ASEAN NCAP Q3 2019 on Toyota Majesty/Granvia* [Online]. Available from: http://www.aseancap.org/v2/?p=4671

ASEAN NCAP (2019). *Study of Vehicle Rearward Visibility for Motorcycle Safety in Malaysia and Indonesia* [Online]. Available from: http://www.aseancap.org/v2/?p=4697

Automotive World (2013). *ANCAP: Choice grows for ASEAN car buyers when it comes to safety* [Online]. Available from: www.automotiveworld.com

Carhs.training GmbH (2013). Carhs SafetyCompanion 2013.

Carlist.my (2016). *ESC Mandatory In Malaysia Effective 1 June 2018* [Online]. Available from: https://www.carlist.my/news/esc-mandatory-malaysia-effective-1-june-2018/43151/

Deutsche Bank Research (2011). *ASEAN auto market – Growing in the shadow of China and India*, September 29, 2011. www.dbresearch.com/PROD/DBR_INTERNET_EN-PROD/PROD0000000000278738.PDF

Euro NCAP 2010-2015 Strategic Roadmap [Online]. Available from: http://www.euroncap.com

GNCAP (2011). ASEAN NCAP: *Making Cars Safer in ASEAN Region*, December 8, 2012. www.globalncap.org/News/News_archive/2011/Pages/making-cars-safer.aspx

GNCAPa (2012). *Largest Ever Meeting of NCAPs Held in Malaysia*, May 28, 2012. www.globalncap.org/News/News_archive/2012/Pages/LargestEverMeetingofNCAPsheldInMalaysia.aspx

GNCAPb (2012). *ASEAN NCAP Launches Its Phase I Crash Test Programme*, November 16, 2012. www.globalncap.org/News/News_archive/2012/Pages/ASEANNCAPlaunchesitsPhaseIcrashtestprogramme.aspx

GNCAP (2017). *Creating A Global Market For Vehicle Safety* [Online]. Available from: http://www.globalncap.org/wp-content/uploads/2017/06/Market-for-Vehicle-Safety.pdf

Khairil Anwar, A.K. (2018). *Reach For The Stars: The ASEAN NCAP Story*, SAE Malaysia.

Lam, J., Dennis, N., Dix, J., Lambrecht, M. et al. (2014). *A Comparison of the NHTSA Research Offset Oblique and Small Overlap Impact Tests and the IIHS Moderate and Small Overlap Tests*, SAE Int. J. Trans. Safety 2(2):268-278

Ministry of Domestic Trade and Consumer Affairs (2019). *ASEAN NCAP Diwajibkan Mulai 1 Mac 2020* [Online]. Available from: https://www.kpdnhep.gov.my/asean-ncap-diwajibkan-mulai-1-mac-2020/?lang=en

National Highway Traffic Safety Administration (NHTSA) (2015). *Overview of NHTSA Priority Plan for Vehicle Safety and Fuel Economy, 2015 to 2017* [Online]. Available from file:///C:/Users/user/Downloads/NVS_priority-plan-June2015_final.pdf

Paultan.org (2016). *Stability Control Mandatory in Malaysia by June 2018* [Online]. Available from: https://paultan.org/2016/11/29/stability-control-mandatory-in-malaysia-by-june-2018/

Paultan.org (2019). *ASEAN NCAP and KPDNHEP launch safety labels for showroom vehicles – compulsory from March 1, 2020* [Online]. Available from: https://paultan.org/2019/02/12/asean-ncap-and-kpdnhep-launch-safety-labels-for-showroom-vehicles-compulsory-from-march-1-2020/

Todayonline.com (2016). *Malaysia Mandates Stability Control For All New Cars* [Online]. Available from: https://www.todayonline.com/world/asia/malaysia-mandates-stability-control-all-new-cars

United Nations Economic Commission for Europe (UNECE) (2008). Global Technical Regulation (UN) No. 8, Electronic Stability Control Systems [Online]. Available from: http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29glob_registry.html [Google Scholar]

Van Ratingen, Michiel R. et al., (2011). Beyond NCAP: *Promoting New Advancements In Safety* [Online]. https://www-esv.nhtsa.dot.gov/Proceedings/22/files/Session%2011%20Oral.pdf

WHO (2011). *Global Plan for the Decade of Action for Road Safety 2011-2020*, World Health Organization, Geneva. [Online]. Available from: https://www.who.int/roadsafety/decade_of_action/plan/en/

WHO (2013). *Global status report on road safety: Time for action*. World Health Organization, Geneva. 2013.

WHO (2018). *Global status report on road safety: Time for action*. World Health Organization, Geneva. 2018.

Yamakawa, H. (2018). *ASEAN New Car Sales Reach 3.33 Million in 2017: Two-thirds the scale of the Japanese market*, IIST e-Magazine. May 31, 2018.www.iist.or.jp/en-m/2018/0279-1077/

Zulhaidi, M.J., Khairil Anwar, A.K., and Ahmad Farhan S. (2013). ASEAN NCAP – The best bet for vehicle safety in the region's safe system? *International Journal of Trade, Economics & Finance, 4(6)*: 358-363.

Zulhaidi, M.J., Mohd Hafzi, M.I., Mohd Syazwan, S., Aqbal Hafeez, A., Khairil Anwar, A.K., and S.V. Wong. (2013). New Car Assessment programme for Southeast Asian Countries (ASEAN NCAP) – A New Paradigm Shift in the ASEAN's Automotive Ecosystem. *In Proc. of 10th Intl. Conf. of Eastern Asia Society for Transportation Studies*, Taipei, Taiwan.

Zulhaidi, M.J., Mohd Hafzi, and Khairil Anwar, A.K. (2015). ASEAN NCAP Contribution in the Automotive Ecosystem. *In Proc. of the 3rd ASEAN Automobile Safety Forum*, Bandung, Indonesia.

Transforming road safety in Asia: Non-governmental Organizations contributing to effective change

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ABSTRACT

Each year, more than 1.35 million people die and many more suffer injuries due to road crashes. Furthermore, road crashes cause low- and middle-income countries to lose between 3 to 5 percent of their GDP. Nongovernmental organizations (NGOs) play a key role in advocating for and implementing evidence-based programs that reduce crashes and assist the injured. The Global Alliance of NGOs for Road Safety (the Alliance) is a member organization that represents 225 NGOs around the world including 36 in Asia. Capacity building for these NGOs is one of the Alliance's three key areas of work, with the aim of equipping grassroots organizations and strengthening the quality and evidence-base of their work.

This article highlights how capacity building has positioned road safety NGOs in Asia as key partners in driving the road safety agenda, and produced positive results at local, national, and regional levels. It discusses the value of data collection training, shares NGOs' best practices, and includes other activities that are contributing to the attainment of SDG road safety specific targets.

Key words: NGOs (Non-governmental Organizations), Capacity building, Road safety, Alliance Advocates, Sustainable Development goals (SDGs) Decade of Action (DOA)

1. Introduction

This paper will focus on the key outcomes of the Alliance Empowerment Program, a capacity-building initiative that builds on the skills and experience of member NGOs enabling them to be more effective advocates for road safety. Learning needs assessment carried out early in the program identified that NGOs could be more effective if they were better equipped to collect, analyze, and present data for advocacy. Recent training projects in Africa and Asia took delegates through the advocacy process using a safe school zone demonstration project that they then replicated in their own contexts, leading to quick wins and demonstrating what can be achieved when NGOs base their work on data and evidence.

2. Alliance Empowerment Program

The Alliance Empowerment Program incorporates face-to-face and online training, mentoring, and small grant schemes. It aims to improve the ability of NGOs working in road safety around the world to design and implement initiatives that significantly reduce the risk of injury and fatality on the world's roads. The Alliance Empowerment Program uses in-house resources and partners with global road safety experts, to build our Alliance members NGOs' skills. Members learn to undertake evidence-based activities that have been identified by the global road safety community as critical to achieving the Sustainable Development Goal targets relating to road safety.

Alliance Advocate training, an intense, face-to-face training that targets NGO leaders to speed up advocacy in road safety at both local and national level.

Since its launch in 2016, the Alliance Advocate training and mentorship have produced 70 Alliance Advocates globally, 25 of whom are from Asia. In the three years of implementation, the program has produced three main outcomes:

- Improved access to key decision makers and influencers in governments leading to formalization and re-enactment and enforcement of road safety laws.
- Unprecedented access to grassroots communities, and increased mobilization through coalitions and focused campaigns.
- Increased media engagement.

The Alliance's monitoring and evaluation (M&E) system is used to continuously learn and improve the planning and delivery of the program, as well as evaluating the performance of member NGOs that have benefited from the program. Through gathering lessons learned, best practice training models can be developed.

3. Burden of road traffic deaths and injuries in Asia

According to the World Health Organization's Global Status Report on Road Safety, Asia has the second highest rate of road traffic injuries and fatalities in the world after Africa[1]. There are 20.7 deaths per 100,000 populations in Asia. Vulnerable populations, such as pedestrians and motorists on two-wheelers are disproportionately affected. Reducing the number of road traffic injuries in developing countries not only increases income growth, but also and generates substantial welfare benefits to societies.

Road safety directly mentioned in two of the Sustainable Development Goals (SDGs):

- SDG 3.6 (Good Health and Wellbeing): By 2020, halve the number of global deaths and injuries from road traffic accidents. (The timeline for this target was aligned to the UN Global Plan for Road Safety[2]. A new target is expected to be negotiated with a 2030 timeline.)
- SDG 11.2 (Sustainable Cities and Communities): By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

Also, of relevance to road safety in an occupational setting, is:

- SDG 8.8 (Decent Work and Economic Growth): Protect labour rights and promote safe working environments

It should be noted that SDG 3.6 target to halve road deaths and injuries, went significantly further than the Decade of Action for Road Safety 2011–2020 (DOA)[3] target that it was based on, which was just "to stabilize and then reduce" road traffic fatalities. SDG 3.6 is, therefore, the strongest commitment that the United Nations (UN) Member States have ever made to road injury prevention. The aim to halve road deaths is also closely aligned with some other existing DOA targets, such as those set by the African Union, the Association of Asian Nations and the European Union.

In Asian countries in general, it has been estimated that for one road traffic death, there are 20 hospitalizations, 50 emergency room visits, and more than 100 minor injuries[4]. Added to this the social impact: pain, grief and suffering, loss of education, work, and damaged relationships, road traffic injuries impose a very large economic burden on the countries affected. Given the gross estimate of 1 percent of GDP in economic loss from road traffic injuries in South Asian countries estimated by the World Bank, this translates to around US$ 25 billion a year, which is more than 50 percent of the total annual amount allocated to development assistance worldwide.[5] The main reason why the burden of road traffic injuries

[1] https://www.who.int/violence_injury_prevention/road_safety_status/2018/en/

[2] https://www.who.int/roadsafety/decade_of_action/plan/en/

[3] https://www.who.int/roadsafety/decade_of_action/plan/en/

[4] https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(17)30276-1/fulltext

[5] https://www.worldbank.org/en/programs/global-road-safety-facility/publication/the-high-toll-of-traffic- injuries-unacceptable-and-preventableDecade of Action - NGOs Perspectives

in this region is so high, can be linked to growth in the number of motor vehicles, poor enforcement of traffic safety regulations, poor quality of roads and vehicles, and inadequate public health infrastructures. Collaborative advocacy action by road safety NGOs can contribute significantly to reducing this high burden.

4. Roles played by NGOs in Asia

The DOA for road safety has facilitated the work of NGOs in many ways. It has provided a clear framework for raising awareness on road safety issues, and it has created a platform for discussion and consultation among all stakeholders. For the first time, it has introduced an important reference mechanism that can be used in the dialogue with governments.

Like NGOs in other regions, many NGOs in Asia began their work as downstream implementer of services, e.g. school trainings, but have shifted their focus to upstream policy work in order to influence national strategies and advocate for legislative changes. They have used the DOA to hold their governments accountable to the commitments within it and to ensure that international obligations are met, thereby trying to influence road safety policy. As part of civil society, these NGOs have played the 'watchdog' role. Where, previously, many NGOs have been branded by the perception that they were anti-government, slowly the view of what NGOs are and do has been transformed presenting them as having a more balanced, dual role of monitor/enforcer and partner, leading to greater trust with their governments. As the DOA comes to a close, NGOs in Asia are increasingly playing a vital role in advancing the road safety agenda in the context of the DOA and beyond. Their credibility has continued to grow and their ability to establish trust and respect with government partners is expected to strengthen.

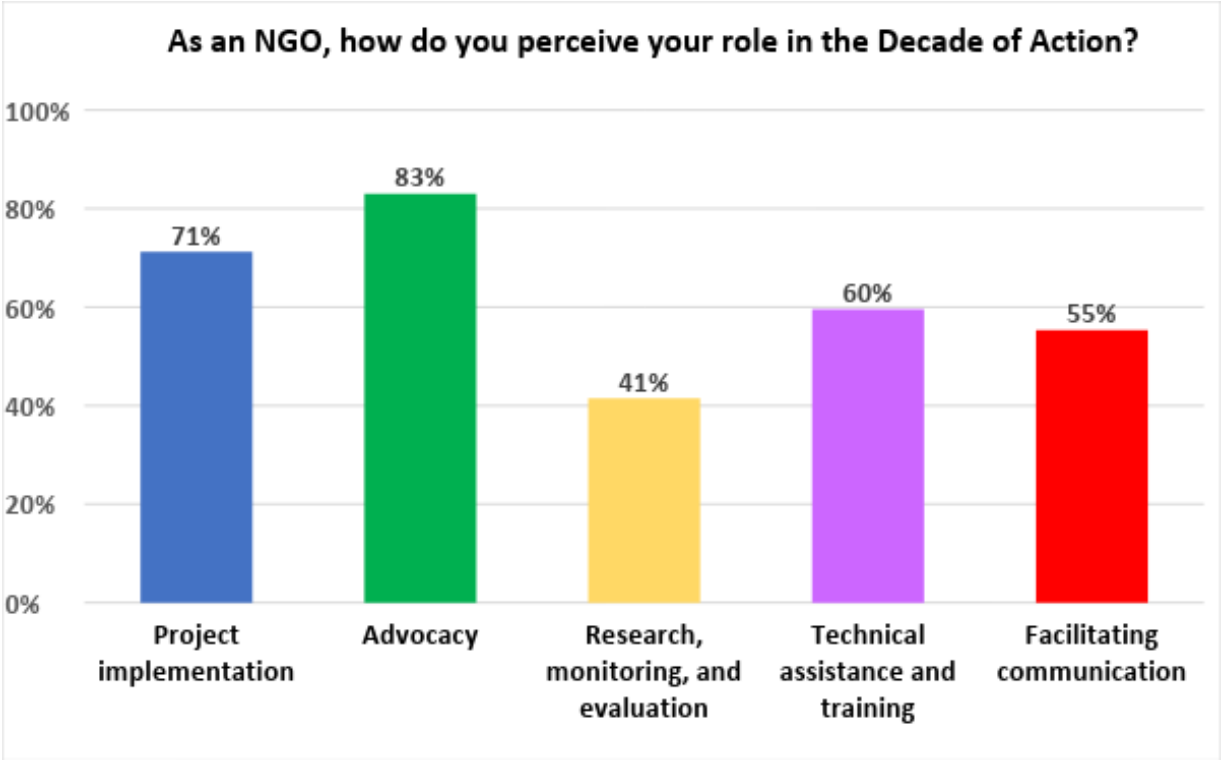
NGOs have focused heavily on nurturing partnerships with their governments; especially in those countries where governments are seen to be leading on road safety issues (e.g. where a national plan has been put in place). In these situations, the role of the NGOs has been to support the government to implement the national plan. Many NGOs are also making genuine attempts to forge partnerships with key stakeholders both inside and outside the NGO world. In doing so, their actions echo a key principle underlying the SDGs: that no single actor can achieve the SDGs on their own and acknowledging SDG 17, which addresses partnerships.

In many countries in Asia, road safety is being addressed strategically at a national level (Malaysia, Thailand, Philippines, India, and Viet Nam). However, at local level in many places, where the challenges are often exacerbated by lack of rod safety knowledge and weak enforcement of existing laws, limited investment is being made. NGOs are bridging this gap between the national and local levels, as many of them are already present at the local level where communities are sometimes hard to reach.

Cognizant to the fact that the lack of reliable government data influences the effectiveness of their activities, NGOs have embarked on collecting primary data themselves on many key road safety indicators. Their efforts can be valuable in monitoring national and local road safety initiatives. This local data is a valuable supplement to the more readily available global data such as the WHO monitoring reports. Some NGOs in Asia have begun using this locally-collected data to hold their governments accountable for their global commitments, including the 12 Voluntary Global Road Safety Performance Targets[6] and the implementation of national plans. NGOs are also advocating for their governments to commit the resources needed to build the institutional support and technical skills and ensure that reliable data is the basis for road safety planning and results.

In 2018, the Alliance surveyed its members to gather an NGO testimony of the DOA, its impact and the contribution and roles of different actors including the NGOs themselves. The figure below is derived from this survey.

[6] Decade of Action - NGOs Perspectives



Most NGOs attested to a shift in their roles during the DOA. A common characteristic of the way that NGOs are now operating has been to take a mixed approach, engaging in both upstream policy making and downstream service delivery. While NGOs generally acknowledge that they can have the strongest impact by focusing on policy work, it is difficult to secure funding for this type of intangible and sometimes political work, and many therefore also undertake service delivery, for which funding is easier to find.

5. Capacity building on data collection for advocacy in Asia

Through hands-on training, NGOs become familiar with tools and techniques that can help drive change. Having identified that strong local data was limiting NGOs' capacity to monitor the effectiveness of road safety interventions, make evidence-based recommendations for new initiatives and hold their governments to account for global commitments such as the DOA and SDGs, the Alliance designed a training program, the Alliance Advocate training, that would equip NGOs to collect, analyze, and use data to advocate for and implement effective, evidence-based road safety interventions. The training was tailored to address the challenge of road safety data in the regions that it was delivered. Grassroots road safety NGO leaders, who became known as "Alliance Advocates", worked on a real-life project on safe school zones in the city that the training was held. Once they had analyzed the data and established their advocacy messages, they had the opportunity to presenting their proposals to influencers and decision makers. Each Alliance Advocate left with an action plan so that they could replicate what they had learned in their own local communities. Using a real-life project presented a strong case for the importance of the data collection process and outcomes. By implementing their action plans, the NGOs have gathered a significant amount of school zone safety data within their respective local communities. Armed with this data, they have advocated strategically for simple but effective low-cost infrastructure improvements around high-risk schools. In doing so, they are actively contributing to the day-to-day safety of thousands of vulnerable road users.

The figure below shows the "quick wins" that the Alliance data training has achieved through its Alliance Advocates in Asia. It shows the number of schools where data collection has been done and how many improvements have been made in the period between January to July 2019.

Country	School	Status
Bangladesh	Mirpur Govt. Primary school	**Improved**
Bangladesh	Motijheel Ideal School & College	**Ongoing**
India	The Government Elementary School	**Improved**
India	Kendriya Vidyalaya school	
India	Ravindra Bharati	**Ongoing**
India	Mahaveer Public School	**Ongoing**
India	Nuabazar Govt. High School	**Ongoing**
India	Manav Mangal School	**Ongoing**
India	MP Bhuta Sion Sarvajanik School	**Ongoing**
India	Gyanodaya Vidyamandir School	**Ongoing**
India	Government Elementary School	**Improved**
India	Nutan Marathi Senior school	**Improved**
India	Ratnakar Vidya mandir	**Ongoing**
India	Sarthi International school	**Improved**
Islamic Republic of Iran*	Shohada, Imam Ali, Azmoodeh, Keshvari, Chamran	**Improved**
Islamic Republic of Iran*	Adib_Neyshaboori	**Improved**
Malaysia	Sekolah Jenis Kebangsaan (T) Kajang	**Ongoing**
Nepal	Mahendra Brukuti school	**Ongoing**
Philippines	Sajay National High School	**Ongoing**
Thailand	Benjamachutit Ratchaburi	**Improved**
Viet Nam	Nguyen Thi Minh Khai Primary School	**Improved**

Out of 21 schools' areas assessed, 42 percent have received one or more road safety improvements. This has included treatments such as painting and maintaining pedestrian crossings, installation of speed calming measures, and erecting school signage among others. Even where physical improvements have not been made, the NGOs are closely following up and providing stop gap measures including volunteering as crossing guards during peak hours when school children are at greatest risk. This current school project in Asia is expected to be completed and evaluated in December 2019 Although it is too early to determine how many children's lives have been saved through the school zone improvements, anecdotal evidence from the school communities around the schools have indicated that parents, teachers and students are feeling safer around school zones, especially during peak hours when children are coming to or leaving school.

6. Case studies and best practices

The examples highlighted below show what can be achieved with strategic investment in road safety NGOs. It includes examples of leaders gaining new skills and mind-sets, and, as a result, NGOs becoming more visible and effective in bringing change that is gradually transforming road safety in the region.

Viet Nam

Speed reduction and School zone safety pilot program

The Asian Injury Prevention (AIP) Foundation is present in several Asia countries including Cambodia, Myanmar, Thailand, and Viet Nam. In Viet Nam, AIP Foundation is implementing the *Slow Zones, Safe Zones* program. It is the first-ever pilot program to reduce speed in school zones in Viet Nam and is supported by Foundation Botnar and the Global Road Safety Partnership. The program focuses on speed reduction and school zone safety through the construction of tailored school-zone modifications like speed bumps, road markings, speed reduction signs, and sidewalks. Additional program components include increased law enforcement, road safety public awareness campaign to promote positive road user behavior, and the development and testing of a nationally applicable road safety e-curriculum.

In Pleiku City, where AIP Foundation is working with Gia Lai National Traffic Safety Committee, speed limits have been reduced to 40 km/h on national roads running past Nguyen Luong Bang Primary School and 30 km/h on provincial roads running past Phan Dang Lou Primary School. After one year of implementation, AIP Foundation found that parents' knowledge of current speed limit and other traffic issues increased from 15.6 percent to 62.4 percent. The average speed of drivers around school zones in Pleiku reduced around 10 km/h for motorcycles and 15-20 km/h for cars, buses, and trucks. Reported student crashes fell from 25.3 percent to 7.4 percent with the percentage of students hurt in road crashes near program schools in Pleiku also falling to 69 percent from 88.3 percent.[7]

AIP Foundation hosted an experience sharing workshop with two other Foundation Botnar and Global Road Safety Partnership grantees, Save the Children and Plan International. The workshop included site visits to the two program schools. Next steps include advocating for continued police enforcement and advocating for continued speed reduction legislation.

Nepal

Strengthening pedestrian safety through legislation

Swatatrata Abhiyan Nepal (SAN) was one of the first cohort of Alliance Advocates in 2016. It used the advocacy skills developed on the training, especially power mapping and message development, to develop stronger relationships with key decision makers in the Ministry of Physical Infrastructure and Transport and traffic police and to build a network of road safety colleagues from other parts of the world. This new energy has enabled them to influence policy at the national level.

The Government of Nepal has now drafted a new road safety law. As a result of its credibility with the government, SAN sits on a parliamentary sub-committee that is reviewing the law and advising its pedestrian safety components, especially through public education. SAN has also been building a national road safety alliance to accelerate action in all seven provinces of Nepal. To date, this national alliance is established in 10 districts of three provinces, with 11 stakeholders in Kathmandu forming the national coordination body.

[7] https://issuu.com/aipfoundation/docs/annual_report_2018_final_interactiv

The Philippines

Increasing affordability, awareness and use of standard child helmets

According to the Online Electronic Injury Surveillance System in the Philippines[8], in the fourth quarter of 2015, of the 6,489 transport/vehicular crash-related injuries, children (0–19 years) accounted for around 30 percent of those injuries, and motorcycle crashes for 62.4 percent. Only 3.9 percent of the injured were wearing helmets.

It is common in the Philippines, to see child passengers on motorcycles with no helmets while the adults are wearing helmets. Safe Kids Worldwide Philippines (SKWP) was also a beneficiary of the first Alliance Advocate training. The program has helped the NGO to accelerate its helmet campaign. It has built partnerships with helmet manufacturers to increase the affordability of standard child helmets for the public, and with motorcycle dealers to encourage corporate social responsibility initiatives to distribute free standardized helmets.

The networking and coalition-building skills gained on the training have helped SKWP to forge an important relationship with a national chain of shopping malls where helmet promotion events increase visibility and attract high levels of participation. Stronger communication skills have led to productive relationships with Bloomberg Fellows, linking the NGO with the government legal office responsible for developing the Implementing Rules and Regulations for the *Children's Safety on Motorcycles Act of 2015* (R.A. 10666). As a result, SKWP was invited to sit on the technical working committee and played an advisory role in bringing the rules and regulations into force. Improved reporting skills enabled Safe Kids Worldwide Philippines to prepare a more substantive account of the distribution of 900 helmets at 17 schools in three cities. At these events, in 2017, 17,468 students and 15,348 parents were reached by key road safety messages.

India

Resource mobilization and partnerships for sustainability

Alliance Advocate TRAX used the action plan developed during training to design a campaign dubbed 'Helmet India'. The program promotes the use of affordable standardized helmets as part of a healthy lifestyle—a lifesaving device, not a luxury item—appropriate for the Indian context, for all ages. Community mobilization, power mapping, coalition building, and constant dialogue with central and state government, enforcement agencies and helmet manufacturers are shaping strategic partnerships and more effective advocacy. TRAX is has conducted research to identify the specific barriers to standardized helmet use among different Indian populations. This analysis has served as a baseline for monitoring and assessing TRAX interventions. TRAX has conducted a motorcycle helmet workshop with the Central Road Research Institute during National Road Safety Week in January 2017 and has organized a state conference on standard helmets in northern India with the support of local authorities and civil society to generate demand and to energize stakeholders to move this work forward. A Memorandum of Understanding (MoU) has been signed with Amity University in New Delhi to promote road safety on campus. Partnerships and collaboration between many actors drive all of TRAX work and ensure that available resources are utilized prudently and results-oriented objectives are achieved. TRAX also recognizes the importance of positive images in the media to change mind-sets and behaviour; they have launched a media content initiative to address this issue. The NGO has begun working with the Advertising Standards Council of India and other stakeholders to advocate for guidelines on the depiction of motor vehicles in advertisements, so as to discourage risk-taking and other harmful behaviours.

As a direct application of data collection skill gained from Advocate training, TRAX is carrying school zone safety audit and a survey of road users, building on work that was initiated by the International Road Federation, India Chapter. Findings from this research have been used to revise plans for the 'Speed 30' campaign and shared with schools in the target area and local officials. In their report, TRAX

[8] http://www.roadsafetyngos.org/walking-the-talk/

made recommendations for improvements that would include small-scale interventions by schools and larger, costlier improvements to infrastructure to be undertaken by local government.

Malaysia

Research and application of saving children's lives on the road

Safe Kids Worldwide Malaysia is domiciled at Department of Community Health at the University Putra Malaysia (UPM). It leads implementation-based studies related to child injury prevention, with road safety as one of five focus areas. Specific areas of research have included compliance behaviour around seat belts, child safety seats, and motorcycle helmets. According to the head researcher[17], one of the greatest challenges to road safety in Malaysia is that people generally feel safe on the roads, and they do not expect to be involved in a crash. This false sense of security is based on the low probability of a crash event occurring over their driving years. And yet, when a crash does happen, the effects can be devastating for individuals and their families.

Communication and coalition building skills gained on the Alliance Advocate training have helped the NGO to promote its standardized child helmet campaign. The involvement of policymakers and other stakeholders in helmet distribution facilitates access to schools and lends credibility to the NGO's work. Strategic use of social media (Facebook and the university website) has created a groundswell of interest in the campaign and media coverage has increased dramatically. Presence on social media has resulted in TV interviews, radio interviews, more than 50 articles in the press, and a strong social media presence. This new experience away from the academic aspects of road safety has made Safe Kids Malaysia more visible in the community and using its research to raise awareness and influence behaviour change.

As a result of the helmet campaign, over 1500 children have received standardized helmets (funded by Halliburton), and 20 schools have participated in education sessions. The evaluation of behaviour change results is still underway, but anecdotal evidence suggests a significant increase in standard helmet use by children with some possible spillover effect expected in helmet use by adults. In Malaysia, the price of standardized helmets is relatively affordable, but the demand is low and consequently the supply has remained low; Safe Kids Malaysia hopes to generate demand through their interventions, which will increase supply and possibly decrease the price.

7. Conclusions

NGOs in Asia are well placed to assist in the design of local solutions to address the road death pandemic, but action is often hampered by gaps and shortcomings caused by inadequate resources, low level skills, lack of focus, absence of government consultation, and poor internal management.
Capacity building has helped NGOs to constantly evaluate their role, and use data more robustly, resulting in successes such as those highlighted in this paper. Smaller NGOs operating at the local level are becoming more organized and playing a key role in gathering primary data in real time. This has given credibility to their work, facilitated more successful partnerships, and enabled them to keep their governments accountable.

With plans underway to launch the Asia Chapter of the Global Alliance of NGOs for Road Safety, NGOs in Asia have the opportunity to reposition themselves and articulate their role even better. This will be particularly important when the DOA comes to a conclusion in 2020. New initiatives and frameworks to advance the global road safety agenda are being defined, such as the Global Road Safety Performance Targets agreed by UN Member States in 2017 and must be tailored to the Asian context. The Asia Chapter will intensify the work started by the Alliance Advocate program in the region, building capacity and amplifying the voice of the NGO network in a more targeted way, aligned to the specific challenges of Alliance member NGOs in Asia.

References

AIP Foundation. (2018). AIP Foundation Annual Report 2018. Retrieved from https://issuu.com/aipfoundation/docs/annual_report_2018_final_interactiv

GBD Diarrhoeal Diseases Collaborators. (2017). Estimates of global, regional, and national morbidity, mortality and aetiologies of diarrhoeal diseases: a systematic analysis for the Global Burden of Disease Study 2015, vol. 17, no. 9, pp. 909-948.

Global Alliance of NGOs for Road Safety. (2017). Walking the Talk. Retrieved from http://www.roadsafetyngos.org/walking-the-talk/

Henderson, M. (2016). Summary: Report on the Learning Needs Assessment for the Global Alliance of Road Safety NGOs. Retrieved from https://drive.google.com/file/d/0B-tiVw1CPXcNQ3pnVUp5YkY4aEU/view

The Decade of Action for Road Safety. (2018). Retrieved from https://drive.google.com/file/d/1uXzrLEaedzqwibiyqOsnQoJqnHHfBE-G/view

United Nations. (2019). Sustainable Development Goal 3. Retrieved from https:/www.sustainabledevelopment.un.org/sdg3

WHO. (2018). Global Status report on road safety. Retrieved from https://www.who.int/violence_injury_prevention/road_safety_status/2018/en/

WHO. (n.d.). Decade of Action for Road Safety 2011-2020. Retrieved from https://www.who.int/roadsafety/decade_of_action/plan/plan_english.pdf?ua=1

Star Ratings for life-saving road improvements in India

Jigesh Bhavsar, Albin Tharakan, Luke Rogers, Greg Smith, and Rob McInerney

ABSTRACT

iRAP assessments have been used to star rate roads in more than half of the 53 ESCAP member countries. Globally, iRAP assessments have now been undertaken in over 100 countries. This large scale of activity is consistent with the United Nations' adoption of targets that will see most travel occurring on roads rated 3-stars or better for all road users by 2030.

With support from the World Bank Global Road Safety Facility (GRSF) and as part of the Bloomberg Initiative for Global Road Safety (BIGRS), some 17,000 km of national, state and city roads have been star rated in India which, according to World Health Organization (WHO) estimates, is where more than one in five of the world's road deaths occur.

The results of the assessments, which include safety Star Ratings and cost and benefit estimates for numerous safety treatment options along each road, are being considered in road designs, upgrades and construction. Two examples are discussed in detail in this paper: the first is in Karnataka and the second in Gujarat. In each of these, iRAP assessments were performed for the existing road (baseline), at the design stage (design) and after the upgrades were made (post-construction). Investments in infrastructure safety countermeasures were implemented resulting in improvements in Star Ratings. These investments have reportedly led to a halving in road deaths on the road in Karnataka (while crash data has not yet been reported for the road in Gujarat). The approach taken in India serves as a valuable model for other UNESCAP member countries to consider.

Key Words: Road Safety, Star Ratings, 3-Star or better, Safer Roads, Saving Lives

1. Introduction

Each year road crashes in India result in enormous levels of death and serious injury. 147,913 people were killed and over 470,975 were seriously injured in road crashes in India in 2017 (MoRTH 2018). With road traffic fatalities now the leading cause worldwide of death for children and young adults of 5 to 29 years of age and 93 percent of road traffic deaths occurring in low and middle-income countries (WHO 2018), key partners in global road safety have come together in an attempt to tackle this public health crisis through accelerated investment in road safety and by fundamentally changing the way we design, build and maintain road infrastructure networks around the world.

The International Road Assessment Programme, iRAP, works in partnership with government and non-government organizations to inspect high-risk roads and develop Star Ratings and Safer Roads Investment Plans, provide training, technology and support that will build and sustain national, regional and local capability and tracks road safety performance so that funding agencies can assess the benefits of their investments (iRAP 2019a).

iRAP assessments have been used to star rate roads in 29 out 53 ESCAP member countries, including India. This large scale of activity is consistent with the United Nations' adoption of targets that will see most travel occurring on roads rated 3-stars or better for all road users by 2030 (WHO, 2016). The Intergovernmental Agreement on the Asian Highway Network encouraged the UN Member countries to ensure that new roads of the Asian Highway network are 3-star or better for all road users and that more than 75 per cent of travel on existing roads is 3-star or better for all road users (UNESCAP 2016).

iRAP, in partnership with the Ministry of Road Transport and Highways, National Highways Authority of India, the World Bank, Bloomberg Philanthropies, Private Concessionaires and State Governments has assessed over 17,000km of roads in India. The iRAP assessments in India are conducted by the local

programme, IndiaRAP, which is hosted by the Asian Institute of Transport Development (AITD) in Delhi with support from FedEx Express. IndiaRAP draws on local technical expertise and works to build capacity among local stakeholders (iRAP 2017).

2. Star Ratings and Safer Roads Investment Plan Process

Figure 1 illustrates the process used to undertake Star Ratings and Safer Roads Investment Plans, which can be used as part of a systematic, proactive approach to road infrastructure risk assessment and renewal based on research about where severe crashes are likely to occur and how they can be prevented (iRAP 2019b). The production of Star Ratings and Safer Road Investment Plans involve data collection, survey and analysis processes. The iRAP assessments make use of road attribute data for more than 50 variables at 100 metre intervals along a road or design (iRAP 2015). For roads, this data is compiled through road surveys that collect digital images of the road using high-resolution cameras as it is driven. After the images are collected, they are viewed by trained coders to record the road attributes.

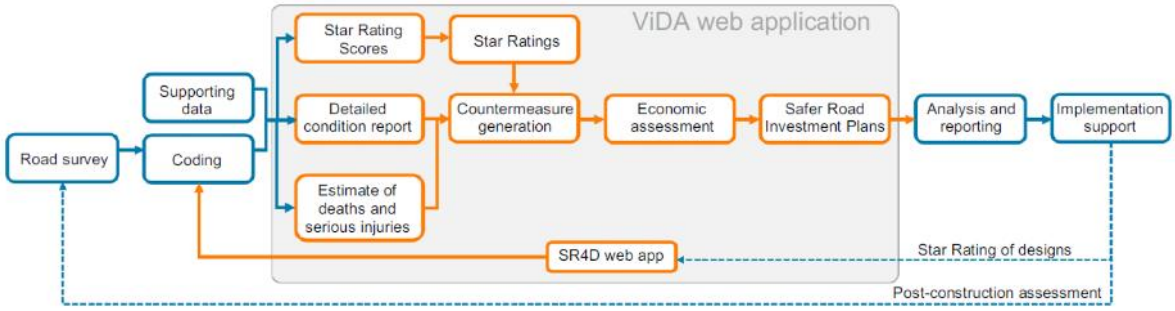
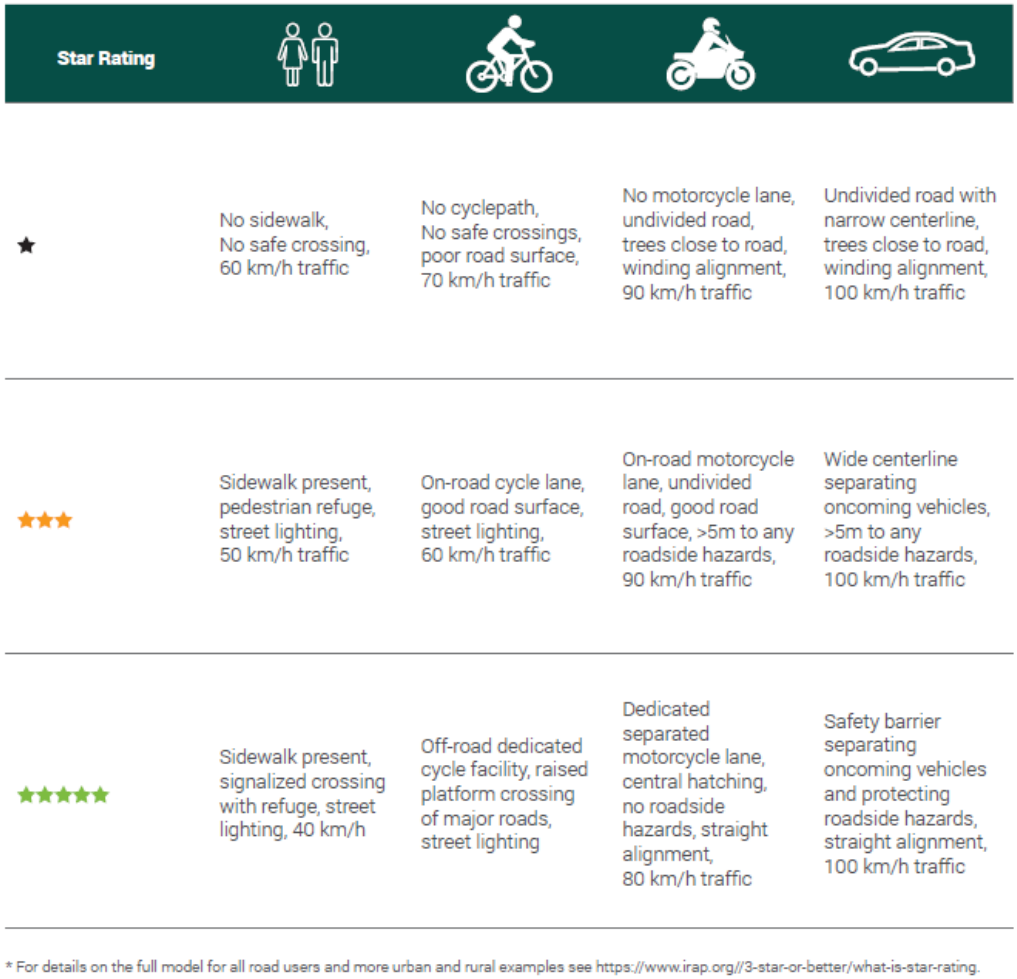


Figure 1: The iRAP Star Rating and Safer Roads Investment Plan process

Star Ratings are a simple and objective measure of the level of safety which is 'built-in' to the road. Five-star road segments are the safest while one-star are the least safe. Star Ratings are produced for four different road user groups, if present on the assessed road network, viz. (i) vehicle occupant, (ii) motorcyclist, (iii) pedestrian and (iv) bicyclist (iRAP 2013).The safest roads, 4- and 5-stars, have road safety attributes that are appropriate for the prevailing traffic speeds (iRAP 2014). Road infrastructure attributes on a safe road might include separation of opposing traffic by a wide median or barrier, good line-marking and intersection design, wide lanes and sealed (paved) shoulders, roadsides free of unprotected hazards such as poles, and good provision for bicyclists and pedestrians such as footpaths, bicycle lanes and pedestrian crossings. The least safe roads (1- and 2-star) do not have road safety attributes that are appropriate for the prevailing traffic speeds. These are often single-carriageway roads with frequent curves and intersections, narrow lanes, unsealed shoulders, poor line markings, hidden intersections and unprotected roadside hazards such as trees, poles and steep embankments close to the side of the road. They also do not adequately accommodate for bicyclists and pedestrians with the use of footpaths, bicycle paths and crossings (refer Figure 2).



Star Rating				
★	No sidewalk, No safe crossing, 60 km/h traffic	No cyclepath, No safe crossings, poor road surface, 70 km/h traffic	No motorcycle lane, undivided road, trees close to road, winding alignment, 90 km/h traffic	Undivided road with narrow centerline, trees close to road, winding alignment, 100 km/h traffic
★★★	Sidewalk present, pedestrian refuge, street lighting, 50 km/h traffic	On-road cycle lane, good road surface, street lighting, 60 km/h traffic	On-road motorcycle lane, undivided road, good road surface, >5m to any roadside hazards, 90 km/h traffic	Wide centerline separating oncoming vehicles, >5m to any roadside hazards, 100 km/h traffic
★★★★★	Sidewalk present, signalized crossing with refuge, street lighting, 40 km/h	Off-road dedicated cycle facility, raised platform crossing of major roads, street lighting	Dedicated separated motorcycle lane, central hatching, no roadside hazards, straight alignment, 80 km/h traffic	Safety barrier separating oncoming vehicles and protecting roadside hazards, straight alignment, 100 km/h traffic

* For details on the full model for all road users and more urban and rural examples see https://www.irap.org//3-star-or-better/what-is-star-rating.

Figure 2: Star Rating of roads – what makes a road safe?

Star Ratings can be completed worldwide, in urban and rural areas, without reference to detailed crash data which is often unavailable in low-income and middle-income countries or is sparse in high-performing high-income countries striving for vision zero outcomes. Whereas Star Ratings indicate the level of safety offered by road infrastructure to its users, Safer Roads Investment Plans are a prioritized list of countermeasures that can cost-effectively improve Star Ratings and reduce infrastructure-related risk. The plans are based on an economic analysis of a range of countermeasures, which is undertaken by comparing the cost of implementing the countermeasure with the reduction in crash costs that would result from its implementation. The plans contain extensive planning and engineering information such as road attribute records, countermeasure proposals and economic assessments for 100 metre segments of a road network. Star Rating and investment plans can be produced for existing roads, designs and newly constructed or upgraded roads. Validation studies have shown that the crash costs per kilometre travelled are approximately halved with each incremental improvement in Star Rating (ITF 2016).

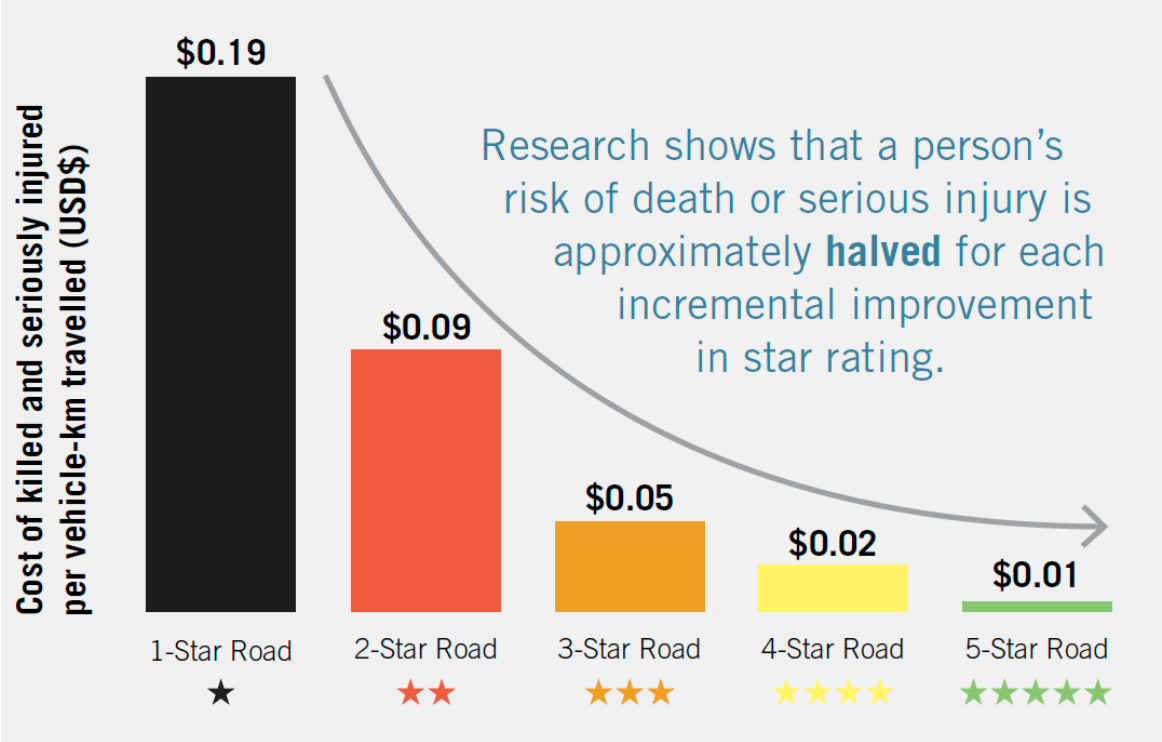


Figure 3: Relationship between Star Rating and crash rates per kilometre travelled

3. iRAP Assessments in India

Some 17,000 km of national, state and city roads have been star rated in Assam, Andhra Pradesh, Delhi, Gujarat, Haryana, Karnataka, Kerala, Maharashtra, Rajasthan, Tamil Nadu, Telangana and Uttar Pradesh. The assessment results, which are summarized in Figure 4, show that most travel occurs on roads rated 1- or 2-stars for all road users, although the percentage of road rated 3-stars or better tends to be better for vehicle occupants than for motorcyclists, pedestrians and bicyclists. The reasons for these results – and a significant reason for the level of trauma on Indian roads - include that 95 percent of the roads where pedestrians are likely to use the road have no formal footpaths and 55 percent of the roads where traffic is traveling at 80km/h is undivided - a key risk factor in head-on crashes.

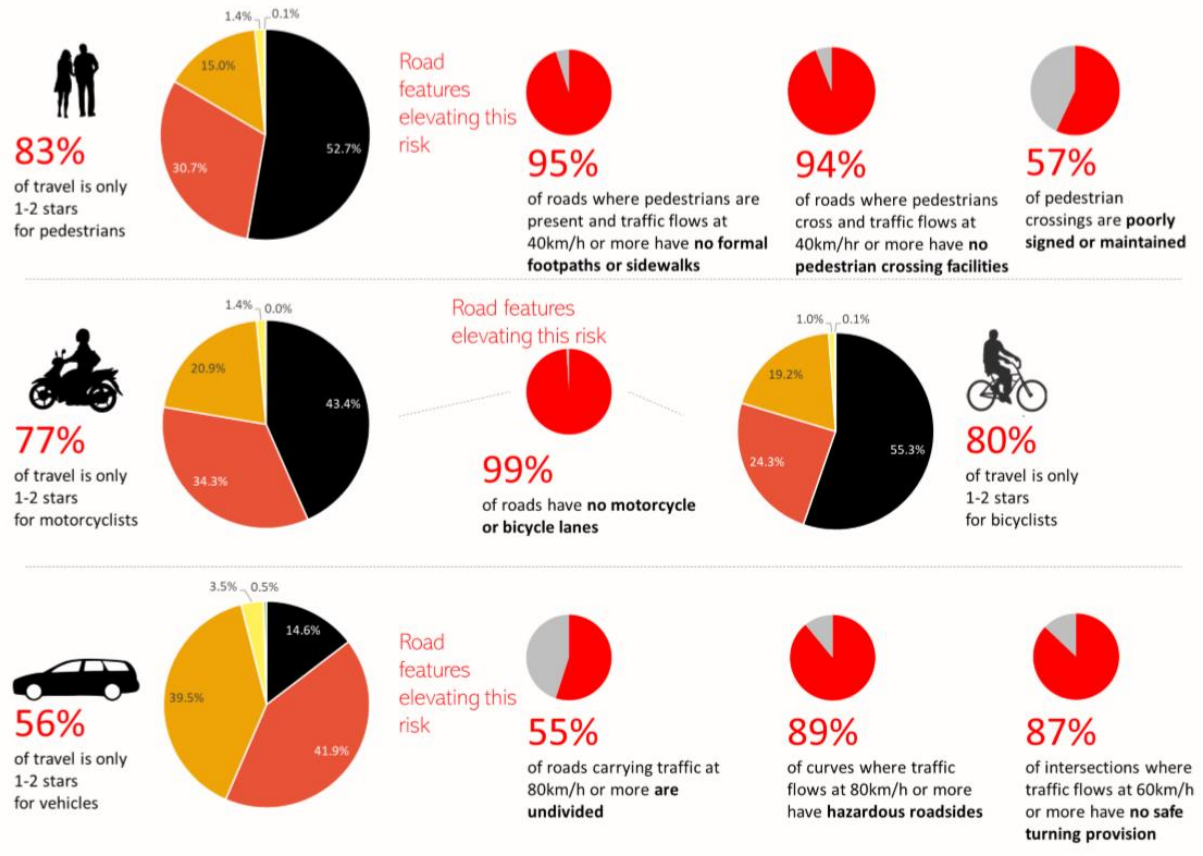


Figure 4: Summary results for 17,000 km of highways

The iRAP assessments also show that with targeted investment in safety countermeasures, thousands of deaths and serious injuries would be prevented. At the largest scale, an investment of INR 32,000 crores in treatments such as traffic calming, footpaths, pedestrian crossings, paved shoulders and intersection enhancements would prevent one million deaths and serious injuries over 20 years.

3.1.1.Demonstration corridors

To help improve the star ratings of national and state highways assessed - and therefore reduce risk - Safe Demonstration Corridors have become a regular feature of road projects financed by the World Bank. Two such demonstration corridors are in the states of Karnataka and Gujarat:

1. The Belgaum–Yaragatti (SH-20) corridor in Karnataka is 56.4km long and was part of the Second Karnataka State Highway Improvement Project (World Bank 2011).
2. The Mehsana–Himmatnagar (SH-55) corridor in Gujarat is 59km long and was part of the Gujarat State Highway Improvement Project-II (World Bank 2013).

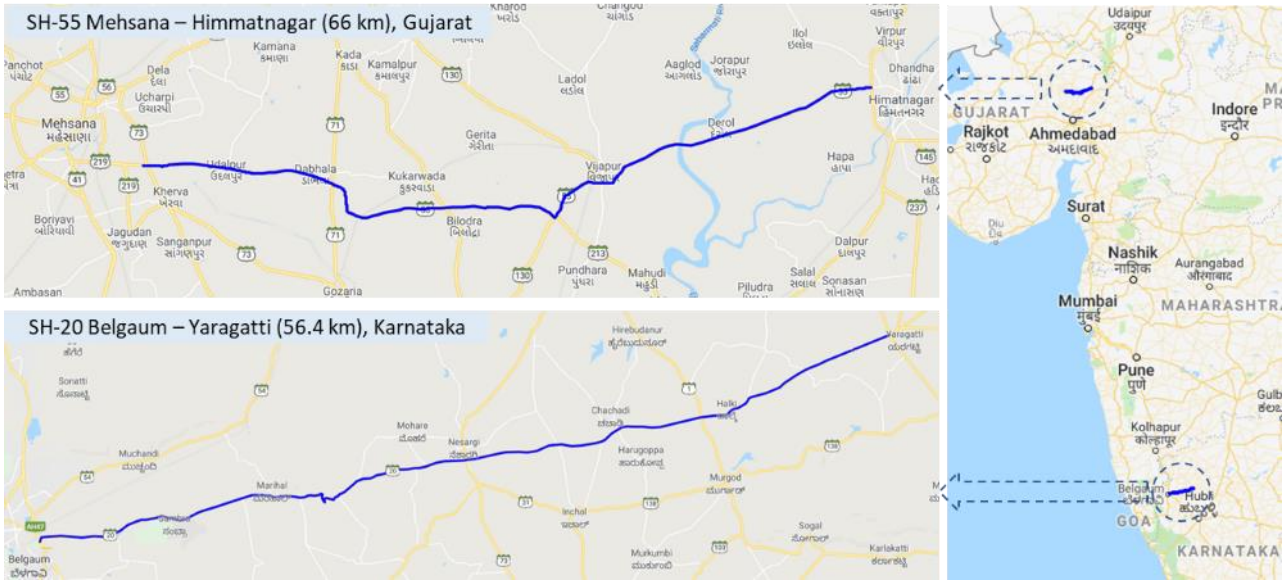


Figure 5: Maps of the Mehsana–Himmatnagar (SH-55) corridor in Gujarat and the Belgaum–Yaragatti (SH-20) corridor in Karnataka

Two other such Safe Demonstration Corridors, one in Andhra Pradesh and one in Tamil Nadu, have been documented by the World Bank (see: Gupta, 2018 and Tvgssshrk, 2018). These reports include valuable information on the over strategy employed by the World Bank and partner road authorities. For each of the corridors, a target of achieving at least 3-stars was set. In addition to the iRAP assessments and road engineering measures, enhanced police enforcement and improved post-crash medical response initiatives were implemented on the Belgaum–Yaragatti (SH-20) corridor in Karnataka (Sharief and Reddy 2018, 5). Further, the Asian Development Bank (ADB) supported safety activities on the corridor by engaging an independent review of the safety treatments identified in the iRAP baseline assessments. The review provided observations which were beneficial for wider initiatives that were undertaken under the multi-sectoral road safety program (Jarvis & Prasad, 2012).

The iRAP assessments of the corridors were undertaken before any upgrades (baseline), during the design stage (design) and after upgrades were complete (post-construction). Based on a comparison between the baseline and post-construction assessments, the key road engineering improvements implemented on the corridors are summarised in Table 1.

Table 1: Summary of infrastructure changes made to the demonstration corridors

Belgaum–Yaragatti (SH-20) corridor in Karnataka	Mehsana–Himmatnagar (SH-55) corridor in Gujarat
• Major intersections improved with provision of a separate lane for right turning vehicles and a physical median in the intersection area. • Traffic calming measures such as yellow painted rumble strips and table-top crossings in the intersection area.	• Upgrade from 2-lane to 4-lanes with provision of a concrete median barrier separating opposing traffic flows. • Provision of paved shoulders on some sections. • Improved road markings, traffic signs and intersections.

• Traffic calming measures such as table-top crossings and/or speed hump in the urban areas. • Provision of overtaking lanes in the hilly areas.	• Streetlights, pedestrian markings and bus bays in the urban areas and major intersections in rural areas.

The improved pedestrian crossing facilities on the Belgaum–Yaragatti (SH-20) corridor in Karnataka include 12 raised crossings (also known as table-top crossings) with a median refuge and 5 raised crossings without a refuge. These raised pedestrian crossings act as a traffic calming measure as the approaching vehicles is require to slow down to comfortably pass the crossing. Significant numbers of marked pedestrian crossings were added to the Mehsana–Himmatnagar (SH-55) corridor in Gujarat. The pedestrian facilities are summarized in Figure 6 and examples of new crossings are show in Figure 7.

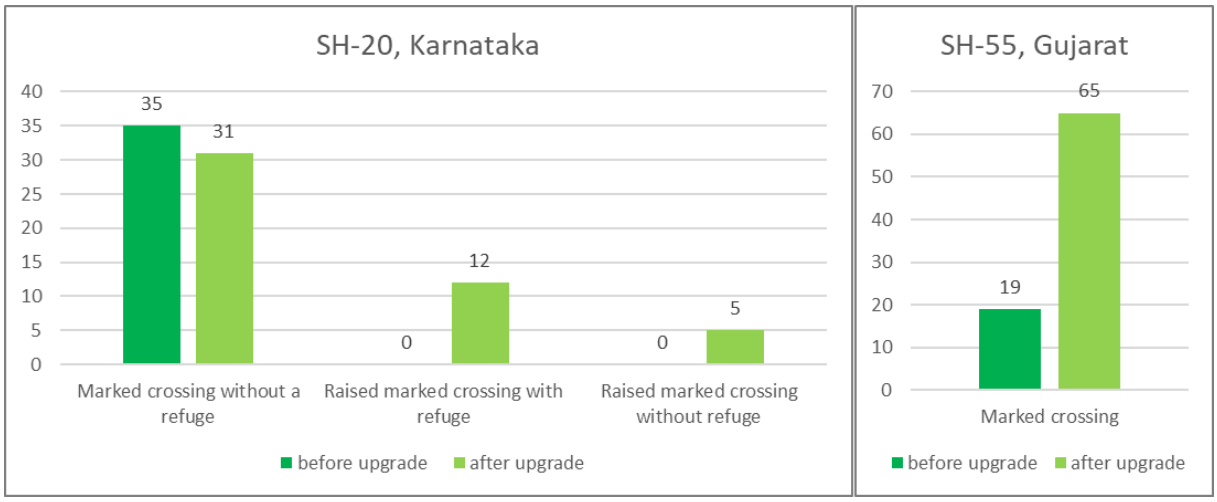


Figure 6: Number of pedestrian crossings on the corridors

Figure 7: Examples pedestrian crossings on the corridors

Seven major intersections on the Belgaum–Yaragatti (SH-20) corridor in Karnataka were redesigned to include right turning lanes and channelization (median in the intersection area). The turn lane reduces the risk for turning vehicles being hit from rear while waiting to take right turn. The physical median on the main road in intersection area helps to channelize flows. On the Mehsana–Himmatnagar (SH-55) corridor in Gujarat, 3 new roundabouts were installed and lane marking and street lighting was improved at numerous intersections. Intersection categories are summarized in Figure 8 and examples of improved intersections are show in Figure 9.

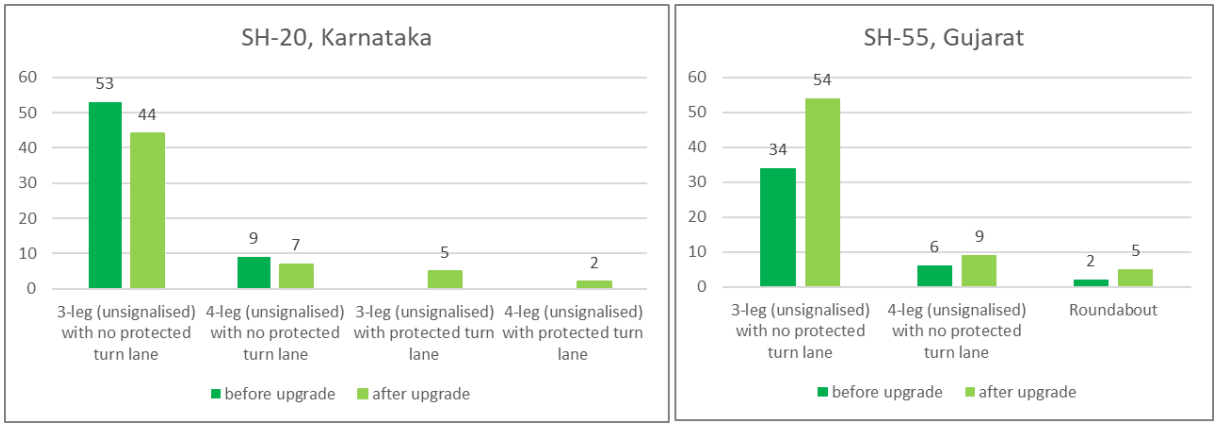


Figure 8: Number of intersections on the corridors

Figure 9: Intersection with turn-lane on the Belgaum–Yaragatti (SH-20) corridor in Karnataka and a roundabout on the Mehsana–Himmatnagar (SH-55) corridor in Gujarat

On the Belgaum–Yaragatti (SH-20) corridor in Karnataka traffic calming, such as thermoplastic rumble strips, speed humps and the previously-mentioned table-top type crossings, serve to slow traffic near intersections and in areas where pedestrians are present. As shown in Figure 10, 11 percent of the corridor now has traffic calming, compared to none before. Figure 10 also shows an example of one of the calming facilities.

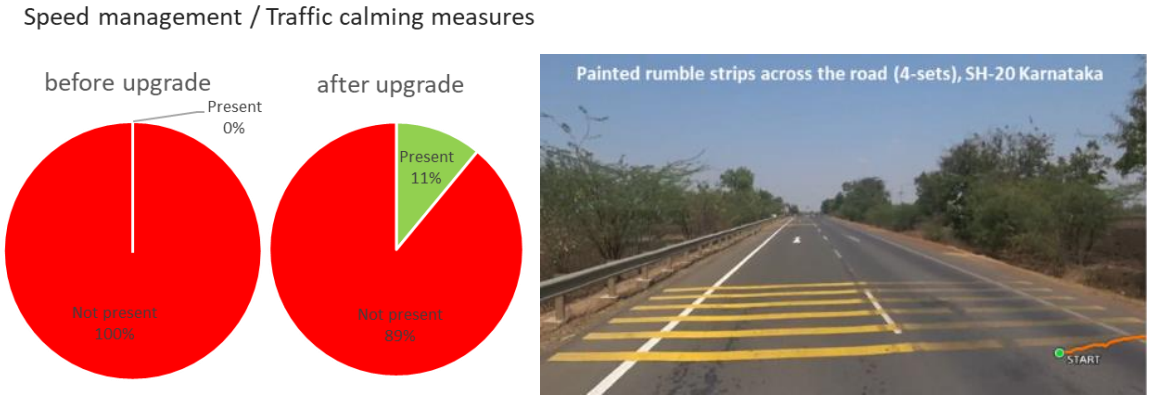


Figure 10: Traffic calming measures on the Belgaum–Yaragatti (SH-20) corridor in Karnataka

Part of the Belgaum–Yaragatti (SH-20) corridor in Karnataka passes through a hilly section where an additional lane has been provided so that light vehicles can more safely overtake heavy vehicles. The length of additional lanes added is shown in Figure 11, as is an example of one of the so-called "2+1" sections of road.

Figure 11: Additional lanes on the Belgaum–Yaragatti (SH-20) corridor in Karnataka

The Mehsana–Himmatnagar (SH-55) corridor in Gujarat is now dual carriageway (2+2 lanes) with a concrete safety barrier in the median and paved shoulders for almost its entire length. The concrete barrier in the median reduces risk of head-on collisions while paved shoulder reduces the risk of run-off road crashes. Median type and paved shoulder categories are summarized in Figure 12 and examples of a section with median barrier and paved shoulder is show in Figure 13. It is noted that other things being equal the addition of traffic lanes is likely to result in an increase in traffic operating speeds. Such an increase in speeds was taken into account in the assessments.

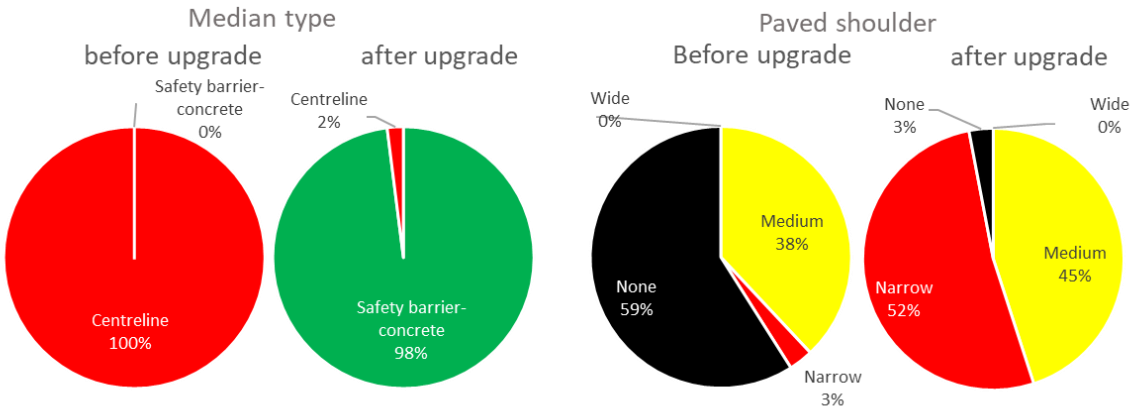


Figure 12: Medians and paved shoulders on the Mehsana–Himmatnagar (SH-55) corridor in Gujarat

Figure 13: Concrete median barrier and paved shoulder on the Mehsana–Himmatnagar (SH-55) corridor in Gujarat

Delineation – lane marking and signs – has been significantly improved on the Mehsana–Himmatnagar (SH-55) corridor in Gujarat. This helps to guide drivers and riders along the road safely. Street lighting has also been added to a section of the corridor. Streetlighting helps to improve safety at pedestrian crossings and for people walking along the roadside and reduces risk at intersections. Delineation and street lighting categories are summarized in Figure 14 and an example of a section with adequate delineation and street lighting is show in Figure 15.

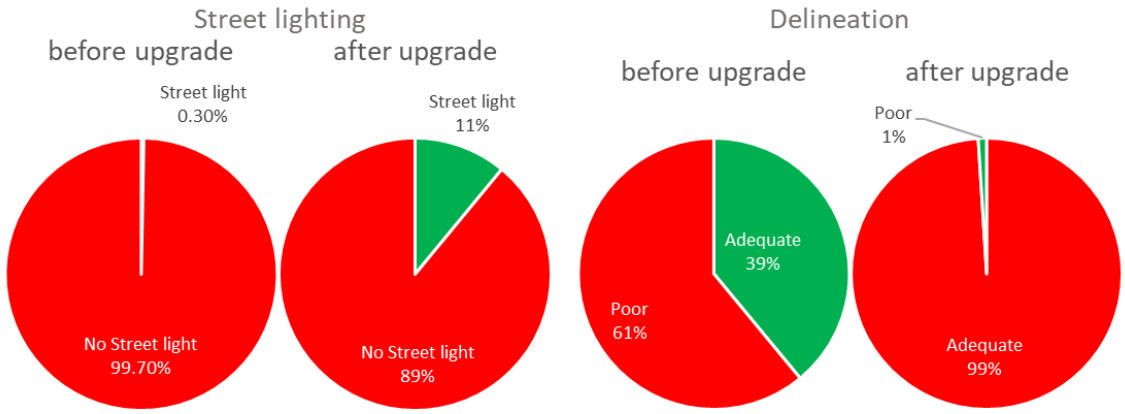


Figure 14: Streetlight and delineation (road markings and signs) on the Mehsana–Himmatnagar (SH-55) corridor in Gujarat

Figure 15: Example of Streetlight and delineation (road markings and signs) on the Mehsana–Himmatnagar (SH-55) corridor in Gujarat

3.1.2.Star Ratings

The assessments showed that the changes made to the corridors improved the Star Ratings. On the Belgaum–Yaragatti (SH-20) corridor in Karnataka, the length rated 3-stars or better for:

- vehicle occupants lifted from 1 percent to 79 percent
- motorcyclists lifted from 0 percent to 44 percent
- pedestrians lifted from 1 percent to 49 percent
- bicyclists lifted from 0 percent to 26 percent

The results are summarised in Table 2.

Table 2: Baseline and post-construction Star Ratings for the Belgaum–Yaragatti (SH-20) corridor in Karnataka (56.4km)

Star Ratings	Vehicle Occupant		Motorcyclist		Pedestrian[9]		Bicyclist	
	Before upgrade	After upgrade	Before upgrade	After upgrade	Before upgrade	After upgrade	Before upgrade	After upgrade
5 Stars	0 %t	0 %	0 %	0 %	0 %t	3 %	0 %	0 %
4 Stars	0 %	8 %	0 %	4 %	0 %	4 %	0 %	0 %
3 Stars	1 %	71 %	0 %	40 %	1 %t	42 %	0 %	26 %
2 Stars	33 %	21 %	18 %	56 %	23 %	23 %	0 %	55 %
1 Star	66 %	0 %	82 %	0 %	76 %	28 %	100 %	19 %
Total	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

On the Belgaum–Yaragatti (SH-20) corridor in Karnataka, the length rated 3-stars or better for:

- vehicle occupants lifted from 35 percent to 98 percent
- motorcyclists lifted from 24 percent to 80 percent
- pedestrians lifted from 3 percent to 22 percent
- bicyclists lifted from 13 percent to 52 percent.

The results are summarised in Table 3. It is noted that the road length before upgrade was 59km but as the road has been built as dual carriageway road and both the carriageways were assessed, the post-construction assessment length is 115km.

Table 3: Baseline and post-construction Star Ratings for the Mehsana–Himmatnagar (SH-55) corridor in Gujarat [10]

Star Ratings	Vehicle Occupant		Motorcyclist		Pedestrian[11]		Bicyclist	
	Before upgrade	After upgrade	Before upgrade	After upgrade	Before upgrade	After upgrade	Before upgrade	After upgrade
5 Stars	0 %	1 %	0 %	0 %	0 %	4 %	0 %	0 %
4 Stars	2 %	6 %	0 %	2 %	0 %	2 %	0 %	5 %
3 Stars	33 %	91 %	24 %	78 %	3 %	16 %	13 %	47 %
2 Stars	16 %	2 %	27 %	19 %	14 %	42 %	29 %	46 %
1 Star	49 %	0 %	49 %	1 %	83 %	36 %	59 %	2 %
Total	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

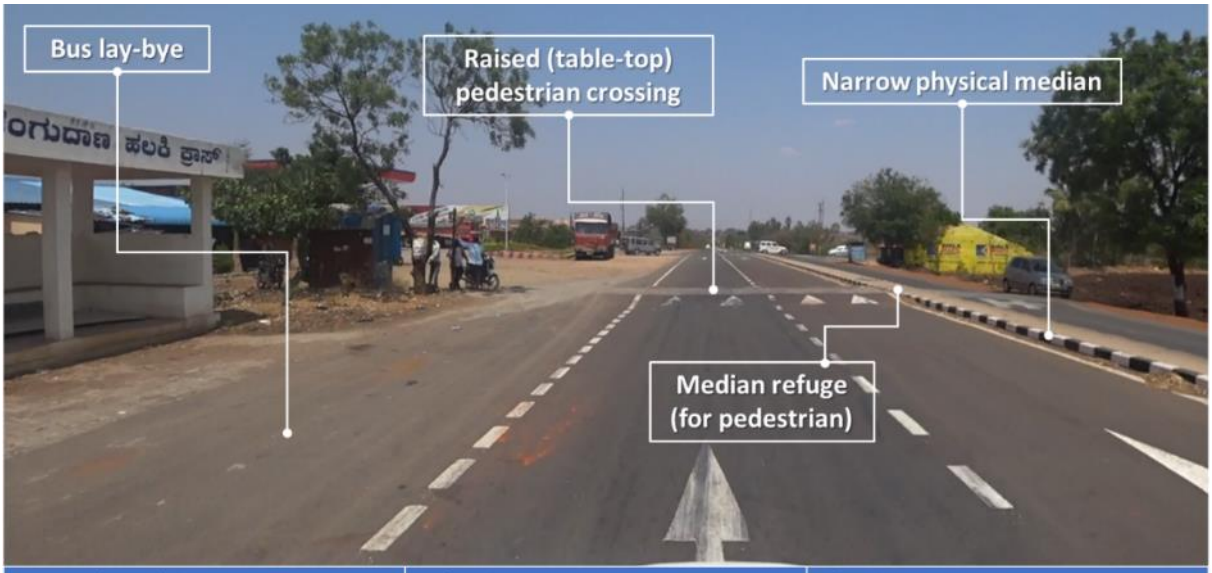
[9] Pedestrian Star Rating reported where significant pedestrian flow exists (where more than 5 pedestrians use the road in a peak hour).

[10] Smoothed Star Ratings are reported in the table except for pedestrian. Smoothed Star Ratings are averaged over longer lengths in order to produce more meaningful results as the Star Ratings may differ every 100m of road length.

[11] Pedestrian Star Rating reported where significant pedestrian flow exists (where more than 5 pedestrians use the road in a peak hour)

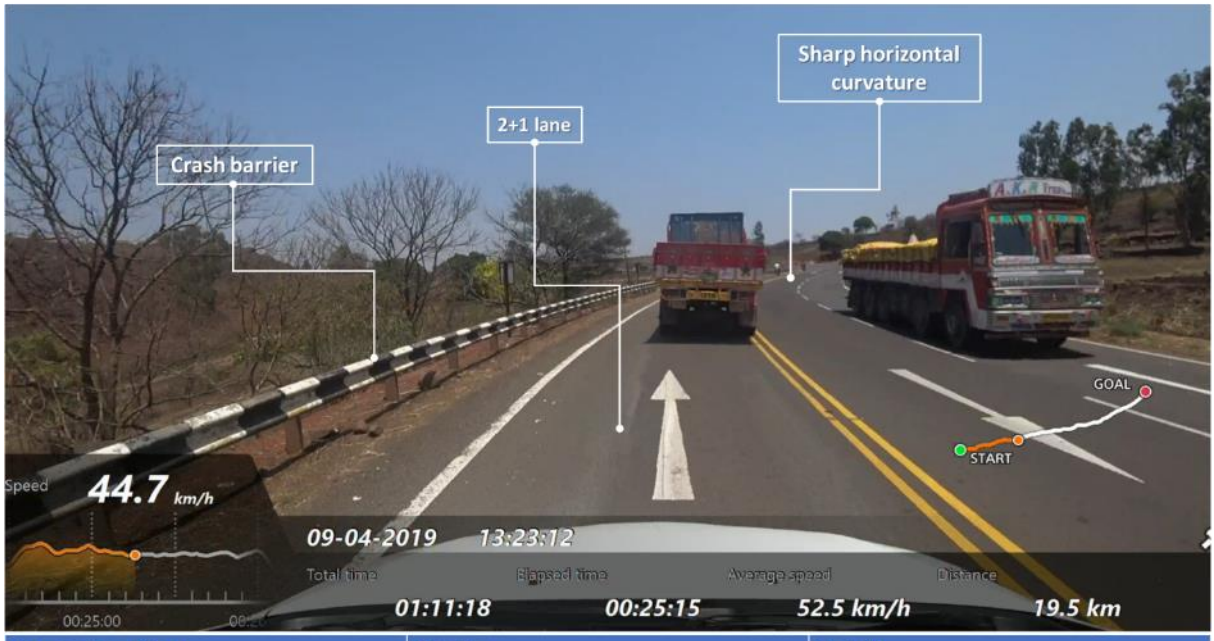
Figure 16-22 show examples of the baseline and post-construction star ratings at a series of locations on the corridors.

Figure 16 Baseline and post-construction image, Km 22.2 on the Belgaum–Yaragatti (SH-20) corridor in Karnataka



Key road conditions	Before improvement	After improvement
Facilities for pedestrian	None	Bus lay-bye and Raised pedestrian crossing with refuge space in the median
Road markings	Poor	Adequate
Type of intersection	4-leg intersection	4-leg intersection with additional lane for right-turning vehicles
Intersection markings and signages	Poor	Adequate
Star Ratings	★	★★★
	★	★★★
	★★	★★★
	★★	★★★★

Figure 17: Improved intersection and pedestrian facility, Km 43.5 on the Belgaum–Yaragatti (SH-20) corridor in Karnataka



Key road conditions	Baseline	As built
Road and curvature markings	Poor	Adequate
Number of lanes	1 in each direction	2+1
Roadside hazards	Trees and steep slope	Metal crash barrier
Star Ratings	★★	★★★
	★★	★★★

Figure 18: Improved road with 2+1 lane and curve delineation, Km 19.5 on the Belgaum–Yaragatti (SH-20) corridor in Karnataka

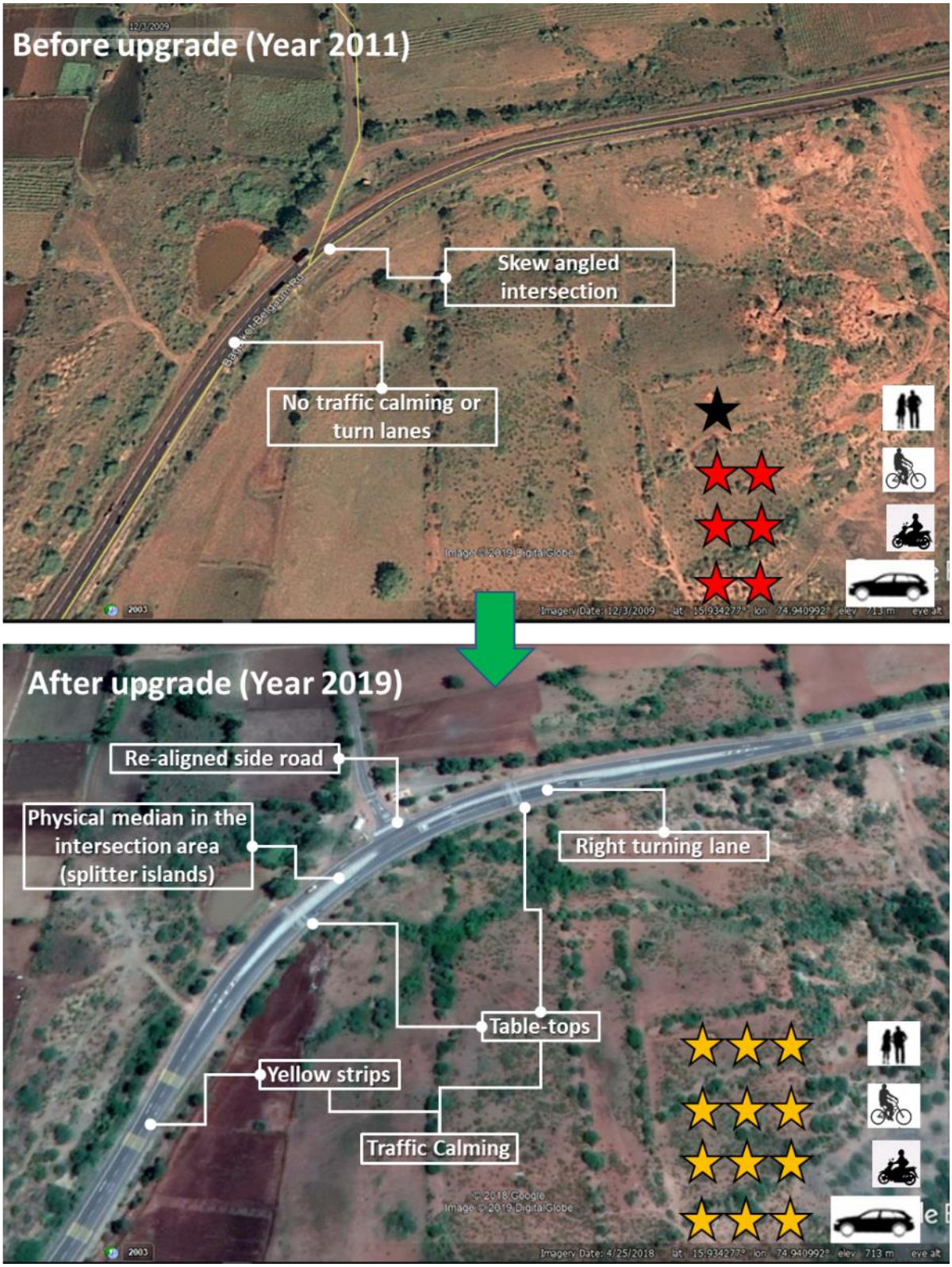


Figure 19: Baseline and post-construction images of an intersection, Km 46.9 on the Belgaum–Yaragatti (SH-20) corridor in Karnataka

Figure 20: Baseline and post-construction images, Km 118.3 on the Mehsana–Himmatnagar (SH-55) corridor in Gujarat

Figure 21: Baseline and post-construction image of an intersection, Km 126.9 on the Mehsana–Himmatnagar (SH-55) corridor in Gujarat

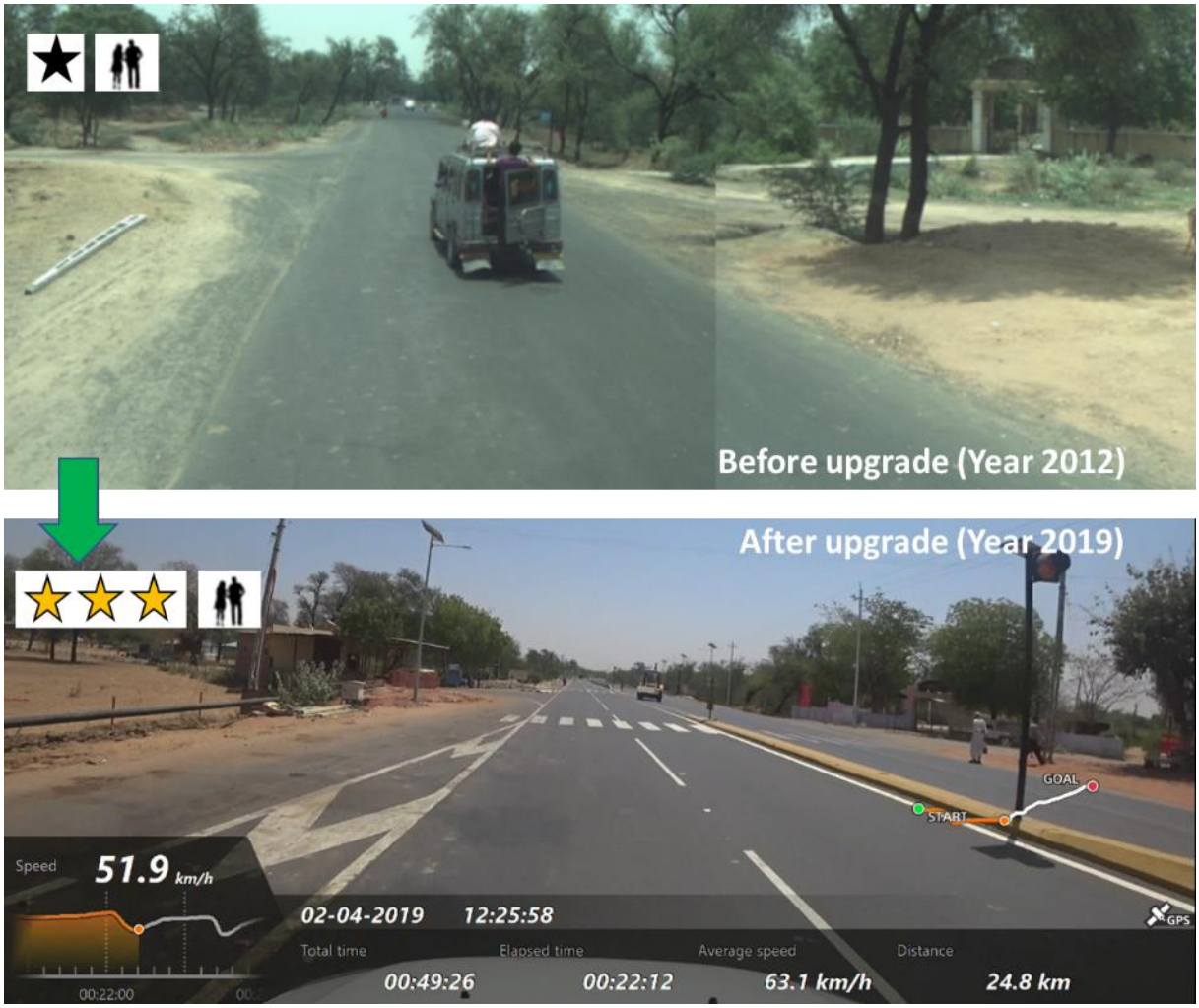


Figure 22: Baseline and post-construction images of pedestrian facilities, Km 134.2 on the Mehsana–Himmatnagar (SH-55) corridor in Gujarat

3.1.3. Deaths and injuries

During the baseline iRAP assessments, independent crash data collection studies were commissioned on to develop a better understanding of both the level of trauma and the types of crashes that occur (JPRI 2012a). The study on the Belgaum–Yaragatti (SH-20) corridor in Karnataka showed that about two-third (63 percent) of the crashes resulted in fatality or grievous injury. The proportion of vehicles involved in these crashes were 30 percent trucks, 27 percent cars and 16 percent farm tractors. A study on a road that is very similar to Mehsana–Himmatnagar (SH-55) corridor in Gujarat showed a high proportion of head-on crashes (39 percent) followed by pedestrian hit by vehicle (26 percent).

Reported crash data for the years immediately prior to improvements to the Belgaum–Yaragatti (SH-20) corridor in Karnataka and immediately after the improvements was initially documented by Sahrief and Reddy (2018) and subsequently by Kumar, Tvgssshrk and Tadimalla (2019). The results, summarized in Figure 23, indicate a reduction in annual average deaths from 49.5 to 22.5 (a 54 percent reduction) and a reduction in annual average injuries from 290.5 to 166.5 (a 42 percent reduction). That is, an average of 27 deaths and 124 injuries prevented per year. Notably, the iRAP baseline and post-construction assessments estimated that a 53 percent reduction in deaths and serious injuries would occur.

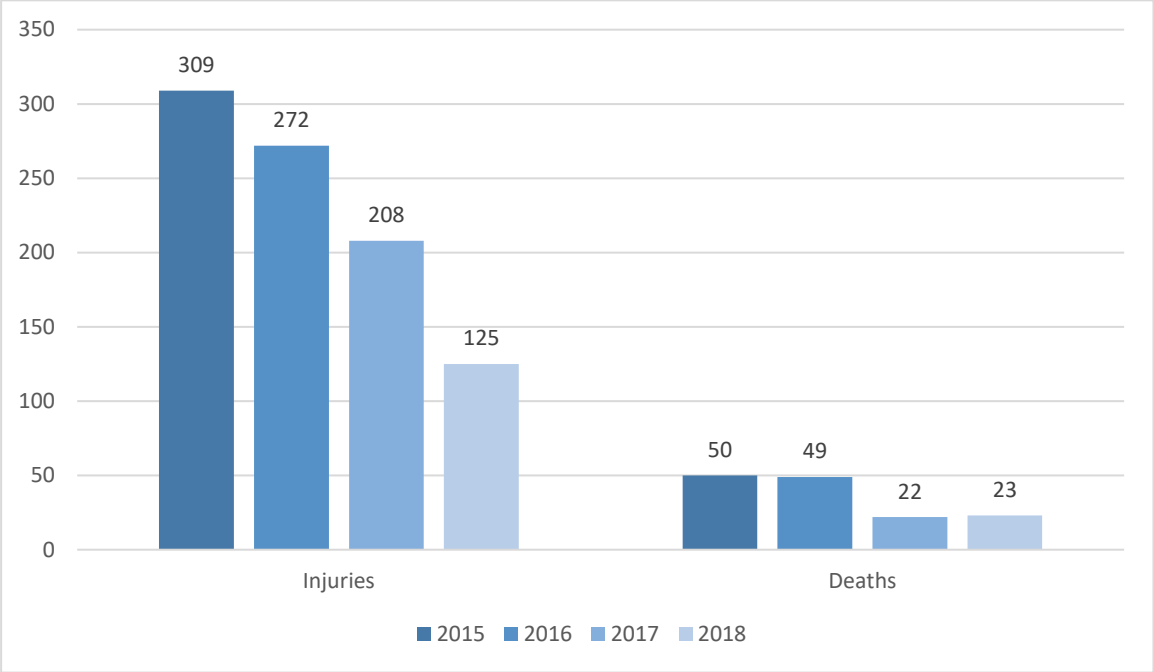


Figure 23: Annual deaths injuries on Belgaum–Yaragatti (SH-20) corridor in Karnataka, 2015-2018

It is acknowledged that this sample size – just two years before and after the improvements – is relatively small and therefore may be subject to variation, but these preliminary findings are encouraging. Further, it is noted that the reduction is attributable to only the infrastructure improvements but also multi-sectoral interventions that were mentioned earlier.

At the time of writing, crash data had not yet been reported for the Mehsana–Himmatnagar (SH-55) corridor in Gujarat. However, the iRAP estimated reduction in deaths and severe injury on the corridor calculated by comparing the baseline and post-construction scenario is 24 percent.

4. Business case for large-scale investment in safety

The iRAP assessments that have been performed to date, and the outcomes the demonstration corridors, show that significant progress towards achievement of the Global Road Safety Performance Targets is achievable. Extrapolating across India, a business case analysis estimates that 75 per cent travel on 3-star or better roads by year 2030 will require investment of some 0.3 percent of India's Gross Domestic Product (GDP) per year but will result in 40 percent reduction of deaths and severe injuries. Over 18 million deaths and serious injuries would be avoided over the 20-year life of the road upgrades, with the economic benefit of crash costs avoided amounting to 6 times the cost of investment (iRAP 2018).

5. Conclusion

The scale and rising number of road deaths in India is surely a public health crisis which needs a systematic approach involving better planning, designing and operation of roads. A systematic assessment of major roads in India conducted by iRAP through the locally established programme, IndiaRAP, in partnership with the Ministry of Road Transport and Highways, National Highways Authority of India, the World Bank, Bloomberg Philanthropies, Private Concessionaires and State Governments has revealed lack of safe infrastructure for road users including vulnerable users like pedestrians and bicyclists. The Star Rating of roads has helped the authorities to understand the safety level of existing roads, identify the targeted road safety interventions and vet road designs to encourage inclusion of economically viable and effective safety treatments in road upgrades.

The case study of two roads, one in the state of Karnataka and another in Gujarat, reveals that implementing targeted road safety treatments improved the road length rated 3-star or better. For instance, the road length with 3-star or better for vehicle occupant increased from 35 percent to 98

percent and for motorcyclist it increased from 24 percent to 80 percent after the Mehsana–Himmatnagar (SH-55) corridor in Gujarat was upgraded. Similarly, after upgrades to the Belgaum–Yaragatti (SH-20) corridor in Karnataka were complete, the road length with 3-star or better increased from just 1 percent to 79 percent for vehicle occupant and for pedestrian 79 percent of the urban road length achieved 3-star or better safety ratings. There has been a 54 percent reduction in deaths and 42 percent reduction in injuries – equating to 27 deaths and 124 injuries prevented per year – Belgaum–Yaragatti (SH-20) corridor in Karnataka. The experience in Karnataka and Gujarat are a strong basis for scaling-up targeted safety interventions in India and indeed the approach taken in India serves as a valuable model for other UNESCAP member countries to consider.

References

Gupta, M. (2018). Road safety action pays off, and "demonstration corridors" are here to prove it. Available from https://blogs.worldbank.org/transport/road-safety-action-pays-and-demonstration-corridors-are-here-prove-it. Accessed on 10 October 2019.

iRAP. (2013). iRAP Methodology Fact Sheet4: Crash Types. Available from http://resources.irap.org/Methodology/iRAP%20model%20factsheet%204%20-%20Crash%20types.pdf. Accessed 9 May 2019.

ITF. (2016). Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System. Paris: OECD.

Jarvis, J., & Prasad, K. (2012). Support the Implementation of the Institutional Development and Strengthening Action Plan (IDSAP) Adopted by the Government of Karnataka TA-7667 (IND), Summary Reviw Report of iRAP recommendations for SCDP. VicRoads.

JPRI. (2012a). iRAP Baseline Data Collection in India, Final Report - Karnataka Phase. Coimbatore.

JPRI. (2012b). iRAP Baseline Data Collection in India, Final Report - Gujarat Phase. Coimbatore.

Kumar, A., Tvgssshrk, P. and Tadimalla, S., R. (2019). Human lives need not be lost in road crashes—much less at current levels. Available from https://blogs.worldbank.org/transport/human-lives-need-not-be-lost-road-crashes-much-less-current-levels-0. Accessed 10 October 2019.

MoRTH. (2018). Road Accidents in India - 2017. New Delhi: Transport Research Wing, Ministry of Road Transport and Highways Govt. of India.

Rogers, L. (2015). iRAP India Project Summary. New Delhi: iRAP.

Rogers, L., Smith, G., Devika, K., Kumar, P. H., & Prakash, G. (2012). Star Rating Road Designs: Performance Indicators for Roads in India. Bengaluru: iRAP and KSHIP. Available from https://www.irap.org/2012/12/star-rating-road-designs-india/

Sharief, M., & Reddy, K. (2018). Implementation of Safe Corridor Demonstration Program in Stretch of SH-20 from Yaragatti to Belgaum. Journal of the Indian Roads Congress, 79-3, pp. 5-8.

Tvgssshrk, P. (2018). Building safer roads through better design and better contracts. Available from https://blogs.worldbank.org/transport/building-safer-roads-through-better-design-and-better-contracts. Accessed 10 October 2019.

UNESCAP.(2016). Asian Highway Design Standards for Road Safety Annex-II bis Available from https://www.unescap.org/sites/default/files/AH%20Design%20Standards%20for%20Raod%20Safety%20%20Adopted%20Annex%20II%20bis.pdf.%20Accessed%207%20May%202019.

Unknown. (2013). Second Gujarat State Highway Project. Available from http://projects.worldbank.org/P114827/gujarat-state-highway-project-ii?lang=en. Accessed 9 May 2019.

Unknown. (2014). iRAP Methodology Fact Sheet1: Overview. Available from iRAP http://resources.irap.org/Methodology/iRAP%20model%20factsheet%201%20-%20Overview.pdf. Accessed 9 May 2019.

Unknown. (2015). iRAP Methodology Fact Sheet3: Road Attributes. Available from http://resources.irap.org/Methodology/iRAP%20model%20factsheet%203%20-Road%20attributes.pdf. Accessed 9 May 2019.

Unknown. (2017). New Indian Road Assessment Programme to Save Lives. Available from https://www.irap.org/2017/11/new-indian-road-assessment-programme-to-save-lives/. Accessed 9 May 2019.

Unknown. (2018). The Business Case for Safer Roads. Available from https://www.vaccinesforroads.org/business-case-for-safer-roads/. Accessed 9 May 2019.

Unknown. (2019a). Available from https://www.irap.org/. Accessed 9 May 2019.

Unknown. (2019b). iRAP Specification, Manuals and User Manual Update. Available from http://resources.irap.org/Specifications/iRAP_Coding_Manual_Drive_on_Left.pdf. Accessed 9 May 2019.

World Health Organization. (2016). Developing global targets for road safety risk factors and service delivery mechanisms. Available from https://www.who.int/violence_injury_prevention/road_traffic/road-safety-targets/en/. Accessed 10 October 2019.

World Health Organization. (2018). Global Status Report on Road Safety.

World Bank. (2011). Project Appraisal Document for the Second Karnataka State Highway Improvement Project. Available from http://documents.worldbank.org/curated/en/827871468042298605/pdf/590890PAD0P10710only1910BOX358303B0.pdf. Accessed 7 May 2019.

Road policing in Asia: Considerations for strengthening policy and practice to improve road safety

Dave Cliff, Judy Fleiter, Marcin Flieger, Brett Harman, and Blaise Murphet

ABSTRACT

One aspect of the Global Road Safety Partnership's (GRSP) collaborative work in Asia is the provision of technical road policing support to enhance traffic law enforcement across a range of agencies in Ho Chi Minh City, Bandung, Shanghai, Bangkok, Mumbai and across the Philippines. Improved ability of enforcement agencies to deter illegal/risky road use through effective enforcement practices that align with international good practice is a critical component of this work. International experience shows that data-led, appropriately resourced road policing makes a unique contribution to reducing road trauma. This paper describes the GRSP's road policing capacity building activities in Asia, highlighting some of the key challenges experienced across the region and outlining potential solutions to improve traffic law enforcement.

Key words: Traffic law enforcement, road policing, speed management, capacity building, drink driving

1. Introduction

In 1998, the International Federation of Red Cross and Red Crescent Societies (IFRC) recognized road trauma as a man-made humanitarian crisis in its World Disasters Report. From this recognition, the Global Road Safety Partnership (GRSP) was established, with a particular focus on low- and middle-income countries[12]. It is in these countries where the largest road trauma burden exists. The most recent Global Status Report on Road Safety (World Health Organization, 2018) highlights that the burden of road traffic injuries is disproportionately high in low- and middle-income countries in relation to their populations as well as to the number of motor vehicles in circulation. Regional variation in road traffic injuries also exists. For example, the Global Status Report on Road Safety documents that when compared to the global rate of road traffic deaths (18.2/100,000 population), South East Asia is one of the regions recording a higher burden (20.7/100,000 population). These figures underpin the need for urgent efforts and collaboration to help improve road safety.

One aspect of the GRSP's collaborative work in the Asian region is provision of technical road policing support to enhance traffic law enforcement across a range of agencies in five cities: Ho Chi Minh City, Bandung, Shanghai, Bangkok, Mumbai, and at the national level in the Philippines. Improving the ability of enforcement agencies to deter illegal/risky road use through effective enforcement practices that align with international good practice is a critical component of this work. Appropriate enforcement of comprehensive, evidence-based laws is one of the key countermeasures shown to reduce road crashes and related deaths and injuries (Richard et al, 2018; World Health Organization, 2017). These efforts to improve road traffic law enforcement in the region align with the 2030 Agenda for Sustainable Development. In particular, this work seeks to enhance the ability to reach targets associated with the Sustainable Development Goals (SDGs), specifically, targets 3.6 and 11.2.

Improving the capability of enforcement agencies to effectively enforce road traffic laws should, in turn, lead to reductions in road fatalities (*Target 3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents*). In South East Asia, 43 percent of all road traffic deaths are represented by users of motorized 2 and 3 wheelers (World Health Organization, 2018). Vulnerable road users are over-represented in road trauma in Asia, compared to some other regions. Therefore, this work is also relevant to improving the safety of those who are least protected in an increasingly motorizing region

[12] The GRSP is an IFRC hosted programme with the aim of reducing road trauma by facilitating partnership and collaboration with government, private sector, and civil society stakeholders.

(*Target 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons*).

2. Building Road Policing Capacity in Asia

As part of the Bloomberg Philanthropies Initiative for Global Road Safety (BIGRS 2015-2019), the GRSP is funded to provide technical support to police enforcement agencies in Bandung, Indonesia; Bangkok, Thailand; Ho Chi Minh City, Viet Nam; Mumbai, India; and Shanghai, China. It is important to note that a comprehensive approach to improving road safety is central to the BIGRS city-based initiatives, with police enforcement just one component (along with a focus on infrastructure and safer mobility, mass media campaigns to promote behaviour change, and roadside observational studies to track prevalence of key behavioural risk factors).

Road policing technical support has been characterized by ongoing, face-to-face meetings with senior level officers and operational police, as well as the provision of detailed technical training, coaching and mentoring on a wide range of topics by the GRSP road policing capacity building team. In collaboration with enforcement agencies in each city, and consistent with the behavioural risk factors emphasized by the BIGRS initiative, road policing capacity building training has focused on: leadership training for senior level officers; road safety enforcement practices including safe vehicle intercept techniques; the establishment and operation of roadside checkpoints (to enhance officer safety and promote efficient intercept tactics) and principles and techniques for enforcing drink driving, speeding, and the non-use/incorrect use of helmets, seatbelts and child restraints; effective police communications for enhancing enforcement operations, procedural justice practices; data-led enforcement; and strategic and operational planning and management. Together, this suite of topics represents a comprehensive programme of capacity building that has assisted in raising awareness among police agencies of the importance of and need to enforce existing laws, the need to improve laws that are deficient, and how best to approach challenging and diverse enforcement environments with limited human and other policing resources.

In addition to the work described above, the GRSP is also working with local partners in the Philippines to strengthen the capacity of police to enhance their speed enforcement capability. In recent years, the national government has acted to strengthen road safety laws, including a focus on reducing speeding. For instance, in 2018, a Joint Memorandum Circular was issued by various Departments to promote the ability of Local Government Units (LGUs) to set speed limits on all roads and to establish co-ordination mechanisms between the national government and LGUs. Through its Road Safety Grants Programme, the GRSP has provided funding to various sectors to advocate for strengthened road safety legislation and its implementation. The recently established United Nations Road Safety Trust Fund (UNRSF) recognized the need to appropriately implement the 2019 Joint Memorandum Circular in a sustainable manner and identified this work as worthy of receiving funding as one of its first pilot projects to proceed in 2019/2020. The GRSP and the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), together with local partners in the Philippines, are implementing this work. The project is supporting the implementation of the Joint Memorandum Circular in LGUs to specifically strengthen speed enforcement through the establishment of a core group of enforcement personnel from different enforcement agencies who will receive training from the GRSP road policing capacity building team. This core group of trained enforcement personnel will then provide speed enforcement training at the Local Transportation Office (LTO) district level to promote sustainability of a systematic approach to training and dissemination on speed limit setting and speed enforcement strategies. This programme of work represents a significant step forward in promoting a nationally supported approach to regional and local level speed enforcement in the Philippines.

3. Capacity building challenges

Enhancing the capacity of traffic police to enforce traffic law is a complex undertaking. In the first instance, it is necessary to gain a full appreciation of current legislation in order to determine what aspects of road user behaviour can actually be enforced by police. There is variation in what is possible across jurisdictions. In some instances, helmet wearing is enforceable by police, yet there is no legal requirement for the helmet to be properly fastened. This legislative loophole essentially renders a helmet an ineffective piece of safety equipment because it needs to be properly fitted and fastened to provide

appropriate protection to the wearer. Seatbelt use by all vehicle passengers is another safety equipment-related issue that requires attention in some countries. For instance, in many countries, seatbelt use was initially mandated only for front seat passengers, leaving back seat passengers unprotected by law and unprotected from the physical forces that occur when a vehicle comes to a halt, resulting in the human body being thrown around (or out of) the vehicle. Rear seatbelt use has eventually been mandated in many jurisdictions, however this delay in recognizing the need for all passengers to be appropriately secured has led to the motoring public and some police agencies/officers not placing due importance on the need to ensure all occupants are appropriately restrained.

Another challenge relates to the legal recognition of alcohol as a significant contributor to impaired road use. In jurisdictions where alcohol consumption is not legal (e.g., Indonesia), alcohol-related road use is generally not monitored or enforced. Enforcement agencies may be reluctant to strengthen drink driving enforcement practices because alcohol is banned, and therefore, this behavioural risk factor may not be deemed a high priority for traffic police enforcement activities. It is important to note that a legal ban on alcohol does not necessarily equate to the absence of alcohol as a contributing factor to road trauma in a country. Rather, it highlights one of the challenges faced by authorities when wishing to tackle the road trauma problem. In such circumstances, it is important to understand the prevalence of alcohol impairment and its contribution to road crashes. Requiring blood alcohol concentration testing of all fatally injured drivers and vulnerable road users would assist in this regard.

Having a thorough understanding of existing legislative parameters in any jurisdiction provides an opportunity to engage with police and policy makers to advocate for legal deficiencies to be rectified. Of equal importance is the need to engage with senior management of all police agencies to establish that, for example, they understood the goals of the BIGRS initiative, the expectations that their involvement in the initiative placed on their personnel, and their willingness to engage with the GRSP road policing team to allow capacity building activities to be undertaken. Without securing agreement of senior police management for participation in such an initiative, as well as certainty of their understanding of why enforcement of the key behavioural risk factors is necessary, capacity building activities are unlikely to translate into enhance enforcement practices over time.

Similarly, assessments of enforcement-related equipment were necessary in order to determine enforcement readiness, particularly in regard to checkpoint safety knowledge and equipment, as well as speed and alcohol detection equipment. In some cases, police were ill-equipped to establish safe roadside checkpoints due to a lack of personal protective equipment as well as a lack of practical experience in establishing, conducting and monitoring safe checkpoints. Some other international jurisdictions have also found similar outcomes, for example, the United States of America (Kanable, 2005; Johnson, 2004). Ensuring officer safety must always be the paramount consideration for any roadside enforcement operation. Therefore, reflective vests and other high visibility and checkpoint-related items were procured for some cities to support this need.

Traffic congestion in densely populated, large Asian cities is another key enforcement challenge. There appears to be a constant tension between the need for police agencies to keep traffic flowing and the need to ensure traffic laws are enforced. Establishing roadside checkpoints to conduct regular enforcement activities (e.g., checking for appropriate seatbelt use or conducting breath testing to detect alcohol impairment) can be at odds with internal organizational policies for ensuring traffic congestion is minimized.

A key aspect of the work identified above is the need for senior police leadership to fully appreciate the importance of deterrence-based road policing activities in reducing road crashes. In addition, there is great scope for policing agencies to better understand how data can be used to improve and refine their operations. In many cases, police agencies do not collect data, collect but do not analyze it, or don't readily share data with partner agencies. Enforcement-related data should be collected and analyzed to better inform future enforcement activities. For example, data collected by police while enforcing the law can provide a greater understanding of things such as high alcohol-related crash times, high trauma hours/days across a week, and the sections of the road network that experience high speeds. These types of data can provide essential information to police managers about how and where to deploy enforcement operations to reduce drink driving and speeding, for example.

All the cities mentioned above experience limitations in traffic policing resources, coupled with competing enforcement demands. Limited resourcing is always accompanied by the challenge of effective resource utilization for effective enforcement outputs. Planning is an important element of good management and decision making, especially when resources are restricted (Global Road Safety Partnership, 2007). Sometimes, operational planning (weekly, monthly, yearly) doesn't exist or is not utilized by police agencies. The GRSP has provided training that aims to instill understanding of the need for a strategic enforcement plan (including objectives and goals), as well as the allocation of resources to meet these objectives, which can include preparing and developing procedures/techniques to complete each task/function of the police agency. With the emphasis on data led enforcement, it becomes more crucial for road police to use the data to understand what, why, where and when the problem is, and work to develop plans for how to address it through strategic and targeted enforcement (NHTSA, 2009; WHO, 2010).

4. Considerations for improving policy and practice

The road policing capacity building work described above highlights some key regional lessons that are also likely applicable other regions. Generally, the GRSP capacity building model focuses on three recipient groups: police leaders, frontline operational officers, and internal police trainers. It is vital that all levels of an enforcement agency understand the importance of strategy and tactics to improve road safety outcomes (NHTSA, 2002; Queensland Police Service, 2019). Therefore, engagement with police leadership is vital and their understanding and support of efforts to adopt enhanced practices is critical to success.

Equally, it is essential to involve those police personnel who are responsible for training and professional development within their agency. In the interests of sustainability of training, it is critical to engage with those who will continue on with the training regime to spread it widely throughout an organization, once international support ends (Shuey, 2019). Ho Chi Minh City provides a model example in this regard. The capacity building programme described above is implemented in that city with the full support of instructors from the People's Police Academy. Instructors from that Academy actively participate in the preparation and conduct of all GRSP training alongside international trainers, which enables a comprehensive training agenda with full appreciation of local contextual issues. In addition, training materials are used to develop training programs for PPA cadets to ensure information is transmitted to new enforcement agency members. There is a great need to ensure that knowledge and capacity are retained and transferred in the local policing agencies (Global Road Safety Partnership, 2008). Introducing this knowledge at the academy level will ensure that cadets are exposed to international good practice from the beginning of their career. Alternatively, the work described in the Philippines, where a national training regime for speed enforcement is being implemented that will filter down to regional and local levels is another way to help ensure widespread understanding and dissemination of key enforcement knowledge and practice.

Finally, there is a critical need for enforcement agencies to embrace the importance of collecting and analyzing their own data to guide enforcement activities. Data-led enforcement can provide agencies with options for the efficient allocation of limited enforcement resources. Enforcement agencies face many competing challenges. Therefore, being able to determine where resources are best placed in order to make a positive impact on reducing road crashes and related road trauma is a critical task for enforcement agency leadership. If the road safety-related targets of the SDGs are to be met in the Asian region, enforcement agencies will need to better embrace comprehensive road safety legislation and enforcement of such.

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work described here, as well as the collaborative efforts of all other partners that work on the road safety initiatives described.

References

Global Road Safety Partnership (2007). *Drinking and Driving: a road safety manual for decision-makers and practitioners*. Geneva.

Global Road Safety Partnership (2008). *Speed management: a road safety manual for decision-makers and practitioners*. Geneva.

International Federation of Red Cross and Red Crescent Societies (1998). *World Disasters Report*. Oxford University Press.

Johnson, D.W. (2004). Impaired-driving program assessments: A summary of recommendations (1991 to 2003). NHTSA Report Number DOT HS 809 815.

Kanable, R. (2005). Driving home a message, *Law Enforcement Technology*, 18.
National Highway Traffic Safety Administration (2002). *Saturation Patrols & Sobriety Checkpoints Guide. A How-to Guide for Planning and Publicizing Impaired Driving Enforcement Efforts*. DOT HS 809 063. Washington, DC.

National Highway Traffic Safety Administration (2009). *Data-Driven Approaches to Crime and Traffic Safety (DDACTS): Operational Guidelines*. DOT HS 811 185, Washington, DC.

Queensland Police Service (2019). Traffic Manual Issue 50, Public Edition, Brisbane.

Richard, C. M., Magee, K., Bacon-Abdelmoteleb, P., & Brown, J. L. (2018). *Countermeasures that work: A highway safety countermeasure guide for State Highway Safety Offices, Ninth edition* (Report No. DOT HS 812 478). Washington, DC: National Highway Traffic Safety Administration.

Shuey, R. (2019). Road safety policy and practice: Sharing road safety education and enforcement knowledge and practice throughout developing nations - challenges create opportunities, *Journal of the Australasian College of Road Safety*, 30 (1), 58-65.

World Health Organization (2010). *Data systems: a road safety manual for decision-makers and practitioners*, Geneva.

World Health Organization (2017). *SaveLIVES – A Road Safety Technical Package*, Geneva: Licence: CC BY-NC-SA 3.0 IGO.

World Health Organization (2018). *Global Status Report on Road* Safety, Geneva: Licence: CC BYNC-SA 3.0 IGO.

Managing Road Safety in Ahmedabad

Shivanand Swamy, Nitika Bhanuki and Shalini Sinha

ABSTRACT

Road crash is not just a chance event and it is possible to identify sources of crashes and take preventive measures. Effective management would include analysing data on a continuous basis, developing strategies and monitoring effectiveness. The Geographic Information System (GIS), big data and video surveillance data come in handy in undertaking these tasks. This paper focuses on analysing the trends in road fatalities and injuries in the city of Ahmedabad in India, their spatio-temporal distribution, identification of 'black-spots' and monitoring of user behaviour using First Information Reports1 (2009–2018), big data and video surveillance data.

There are four important observations of the research. First, 'two-wheeler users' along with pedestrians have emerged as a vulnerable group and 'cars' have emerged as the major responsible mode for fatal road crashes. Second, highways in urban areas are more road crash prone than other city roads. Third, using kernel density estimation method, the study identifies hot spots and concludes that 64 locations (46 percent *of the total road crash prone areas) in the city are more prone to road crashes than others. Lastly, this study confirms that effective monitoring using video surveillance does contribute to change in user behaviour.*

Key words: Road safety, road crashes trends, responsible and affected modes, hotspot analysis, kernel density estimation

1. Background

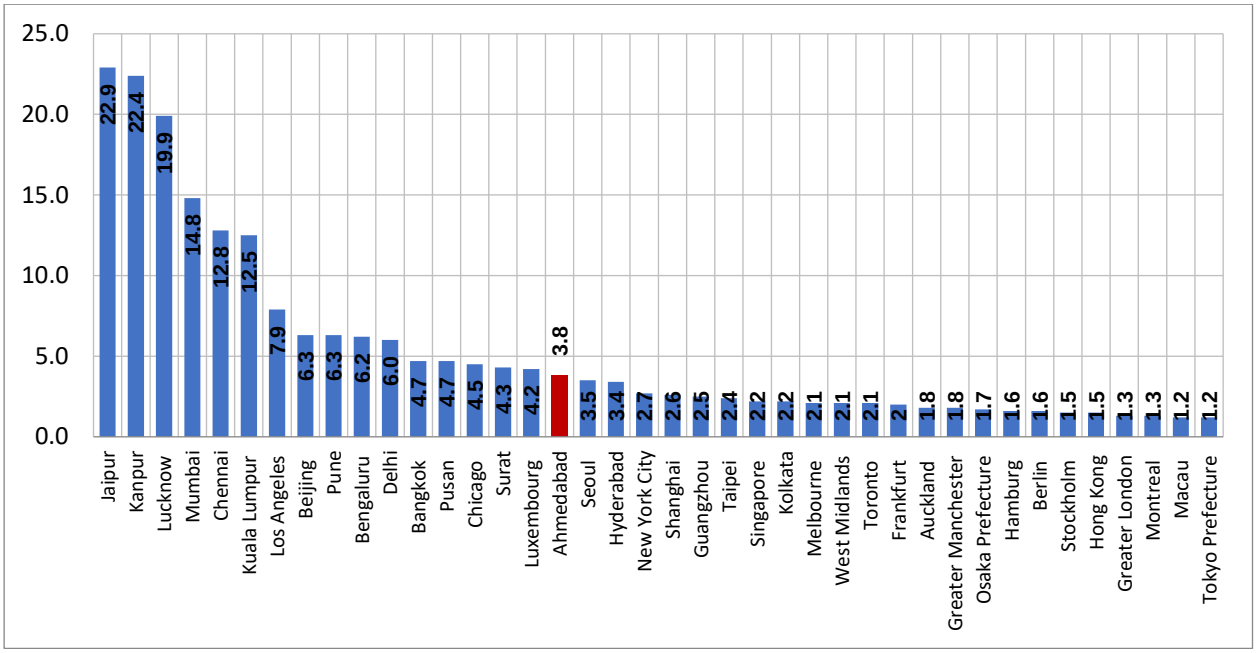
Road safety has emerged as a prime concern globally over the past few decades. Despite significant advances in road safety knowledge, 1.35 million people are killed every year in road traffic crashes around the world. Over 93 percent of the deaths are reported to occur in low- and middle-income countries even though they have only 60 percent of the world's vehicles (World Health Organisation, 2018). The rate of death at the global level per 100,000 people is 18—however, this rises to about 27.5 in low- and middle-income countries while it reduces to about 8.3 for high income countries. Road crashes cost about 3 percent of the GDP across countries (World Health Organisation, 2018). The most vulnerable groups include pedestrians, bicyclists and motorcyclists who account for almost half the road crash deaths (World Health Organisation, 2018). It is observed that road crashes are the 8th leading cause of death in all age groups whereas in the case of children and young people aged 5 to 29, road crashes are now the leading cause of death (World Health Organisation, 2018). It is also recorded that up to 50 million people are seriously injured, many suffer life-long disability due to road crashes (World Health Organisation, 2018) .

Globally, India is ranked 58th in terms of road crash fatality rate (22.6 deaths per 100000 population) (World Health Organisation, 2018). According to official statistics 147,913 persons were killed and 470,975 injured in road traffic crashes in India in 2017 (Ministry of Road Transport and Highways Government of India, 2018). India faces more than double the current roadway crashes when compared to the United States, whereas the roadway length in India is about half of that in the United States (Kar & Datta, 2009).

Urbanization and increased motorized vehicle ownership in recent years have seen many Indian cities report an escalation in 'road traffic accident' (RTA) or 'crash' fatalities and serious injury recordings. As per the Ministry of Road Transport and Highways (MoRTH), Government of India, urban areas accounted for about 42.9 percent (195,723) of the total road crashes in 2017 (MoRTH, 2008). Road fatalities in urban areas in India have reduced by about 11 percent from 57,840 in 2016 to 51,334 in 2017 (Ministry of Road Transport and Highways Government of India, 2018). A decline of about 13

percent is also observed in the case of serious injuries, which have come down from 212,346 in 2016 to 183,703 in 2017.
Indian cities have very high fatality rates (5 to 16.5 per hundred thousand population) compared to other international cities. Data for 50 million-plus cities reported in National Crime Record Bureau (NCRB) and MoRTH reports published in 2015 shows that the average death rate for all million-plus cities combined was 14.7 per 100,000 (NCRB, 2015). It is observed that in a third of these cities, the death rate increased by more than 50 percent in a period of 10 years.

The city of Ahmedabad with a population of 5.5 million (Office of the Registrar General & Census Commissioner, India, 2011) residing within 466 sq.km. of municipal area, fares better in terms of fatal and serious road crashes per hundred thousand population as compared to other cities in India. However, the overall level of service as per the Service Level Benchmarks in Urban Transport issued by Government of India is poor at Level of Service (LOS) 3. (Ministry of Housing and Urban Affairs, 2016b) On a comparative national scale, fatality rate of 3.8 per hundred thousand population in Ahmedabad with 2.8 million registered vehicles is higher than that of most international cities.



Source: (Transport Department Government of the Hong Kong Special Administration Region, 2017) (Ministry of Road Transport and Highways Government of India, 2018)

Figure 24: Fatalities per 100,000 populations – Indian and International City Comparison 2017

2. Database and Method Used

In India, the data regarding road crashes is jointly handled by the City Traffic Police and the City Police. The details of the day-to-day road traffic crashes are recorded in local police stations across the country in the form of an FIR (First Incident Report), once a road crash case is brought to the notice of the police (by anyone involved in the crash, anyone who knows about the crash, or a police officer who comes to know about the crash) or in the form of a 'Medico Legal Case' by a police officer stationed at hospitals. Once the FIR is registered, an investigation team prepares a case file which records the road crash in detail. This is submitted in court for further legal action. The City Traffic Police keeps a record of all road crashes in the city by collecting a copy of the relevant FIR from various police stations in the city. The road crashes data (Fatal and Serious Road Crashes) used for the purpose of this study have been sourced from FIRs (2009–2018) collected from the City Traffic Police Commissioner's office[13].

[13] The source for Figures 2–14 in this paper is the unpublished data collected from the Traffic Police Department in Ahmedabad in 2018.

Along with the road crash locations, data relating to traffic offences was also collected from the traffic police department to understand the risks posed to the road users. The paper adopts a specific set of RTA data focusing on total road crashes, fatal road crashes, fatalities, serious road crashes and serious injury cases in Ahmedabad from 2009 to 2018, plotted spatially on GIS. At an aggregate level, the road crash trends have been analyzed over a period of ten years in terms of numbers and rates (road crashes per 100,000 population, per kilometre length of road length). Comparison of road crashes, both spatially and temporally, has been carried out along with identifying the affected and responsible modes for both. Spatial distribution of road crashes using the Kernel Density Estimations (KDE) has been used to identify the road crash hotspots. This is one of the most widely used methods for road crash analyses. This interpolation technique generalizes the road crash incident location to an area by calculating the density of crashes in the neighbourhood around the road crashes (Bailey & Gatrell, 1995). One of the main advantages of using this method is that the changes in the density are easily identified along with the spread of risk of road crashes. Cluster analysis was also performed to identify specific hotspots for road crashes. For this purpose, the base grid of 200m was used for analysis, based on the average link length, and using the spatial join tool, the fatalities and serious injuries were aggregated in these grids to identify locations.

Interviews were also carried out with the authorities to understand the causes and the remedial actions taken by them.

3. Fatalities and Serious Injuries Trend in Ahmedabad – Temporal and Spatial

Road crash trend analysis over the last decade suggests that fatalities as well as serious injuries have gradually risen in Ahmedabad. In 2018, road traffic road crashes cost 322 lives and seriously injured 440 people in the city (see Figure 25).

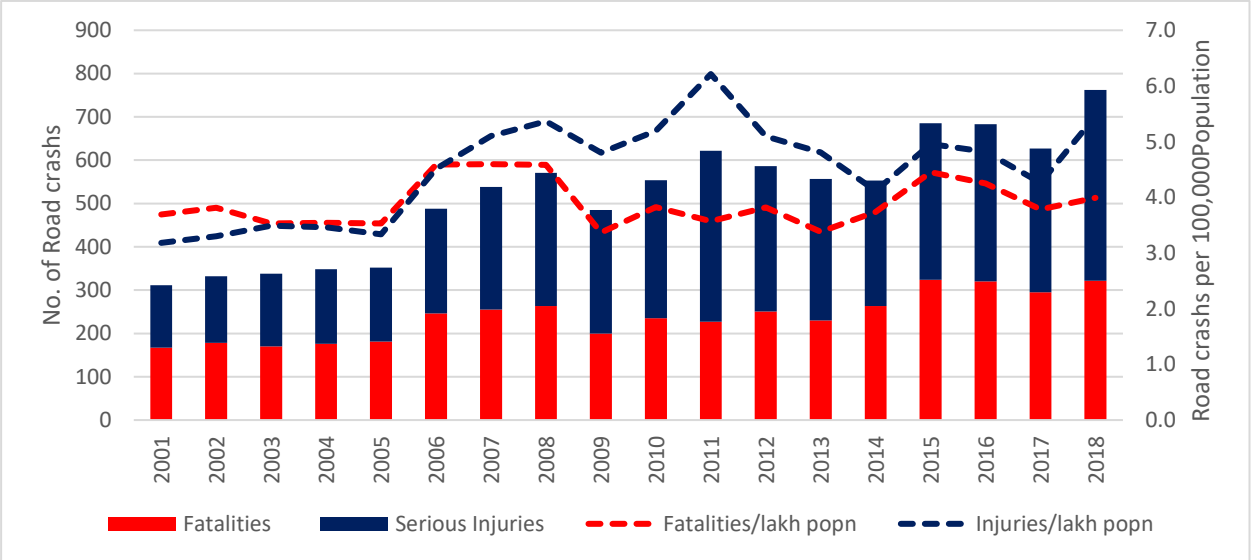


Figure 25: Trend of Fatalities and Serious Injuries in Ahmedabad

Of the total fatalities and serious injuries in the last decade, 80 percent of those affected are males, which is typical of any urban area in a developing country where the male work participation rates are higher than those of females. It is also seen that 78 percent of the fatal and serious road crashes are in the economically productive age groups (between 18–60 years) followed by senior citizens (refer to Figure 26). This indicates vulnerability of the family in the case of road crashes, as the male members are the earning members of the family and such incidents impact the overall socioeconomic condition of the family, affecting the education of children, productivity of the working population and the overall quality of life (World Health Organisation, 2015).

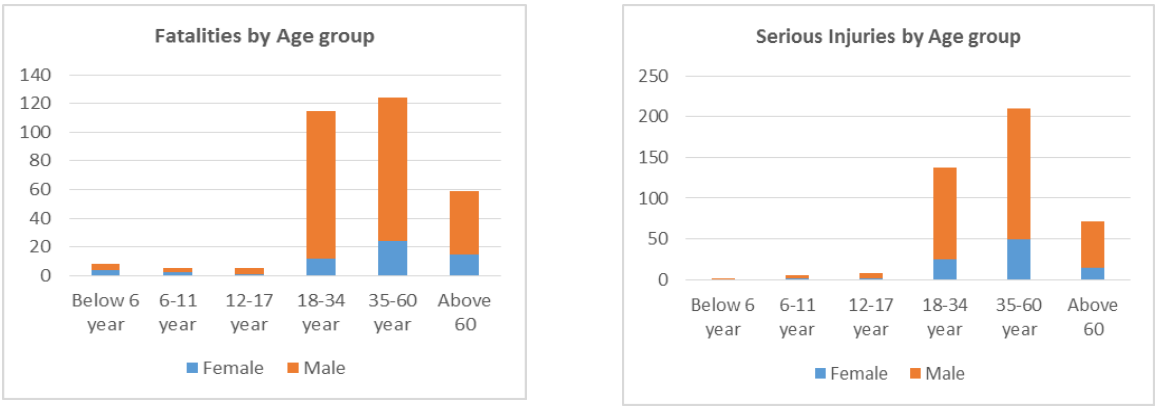


Figure 26: Distribution of Fatalities and Serious Injuries by Age Group

The time of the day also seems to have an impact on road crashes in the city. It is observed that in the case of Ahmedabad, most of the fatal road crashes take place during the peak hours (9am to 11am and 6pm to 8pm). If we compare the 2009 and 2018 numbers, it is seen that the share of fatalities in the evening peak hours have almost doubled, from 4 percent in 2009 to 7 percent in 2018. It is also observed that during the off-peak hours between 11am to 6pm, the proportion of road crashes has increased. This could be attributed to high growth (about 9 percent annually) of motorized vehicles in Ahmedabad albeit with reasonable travel speeds of about 28 km per hour for private vehicles on the road.

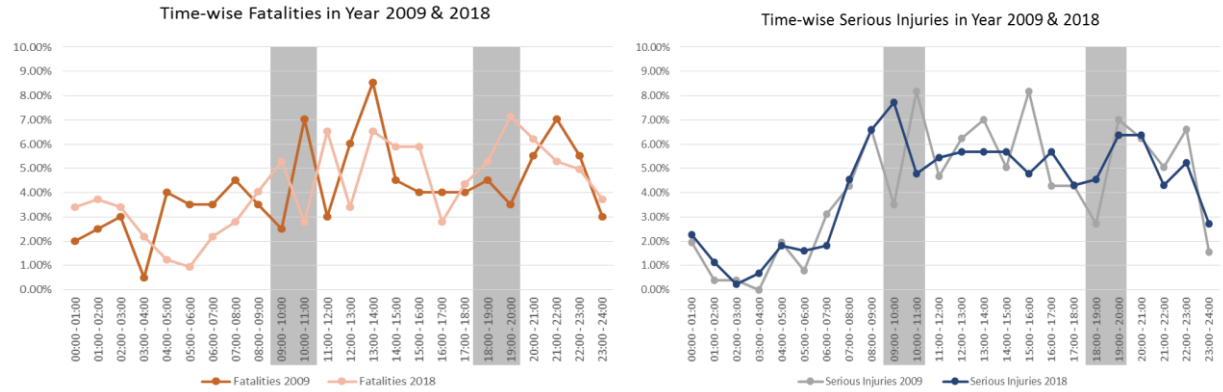
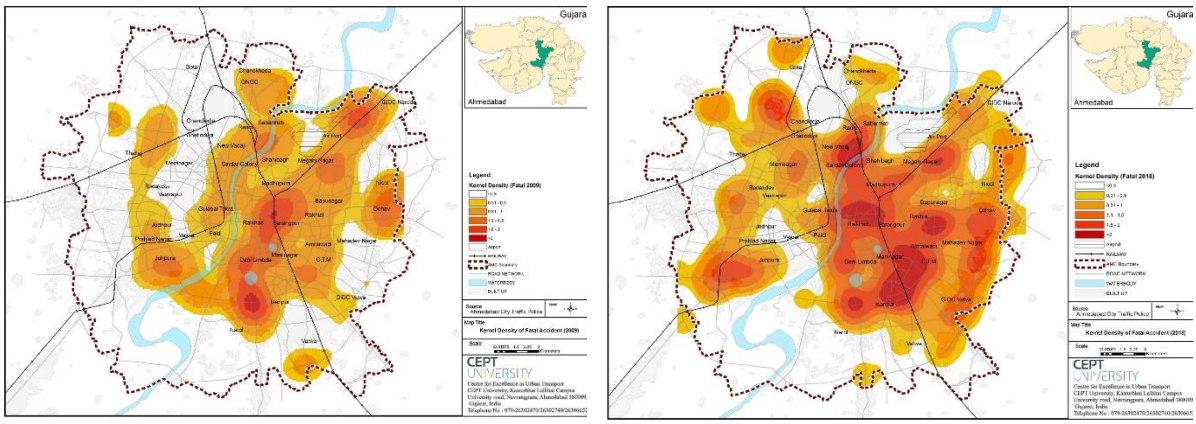


Figure 27: Distribution of Fatalities and Serious Injuries by the Time of the Day

In terms of spatial distribution of fatalities and serious injuries from 2009 to 2018, it is observed that fatalities are higher in the eastern side of the city (67 percent) in comparison to the western side (33 percent). This could be attributed to the intrusion of freight vehicles in the eastern side owing to the presence of industrial land use in the eastern part of the city. As observed, freight vehicles in the eastern part of the city alone account for about 15 percent of the total fatalities compared to 4 percent in the west of Ahmedabad. On the other hand, in the case of serious injuries, western Ahmedabad has a slightly higher share (56 percent) as compared to its eastern part (44 percent). It is also seen here that four-wheelers become the predominant mode contributing to about 26 percent of the injuries in the western part and 11 percent in the eastern part of the city, which could be attributed to higher car use in the western side of the city.

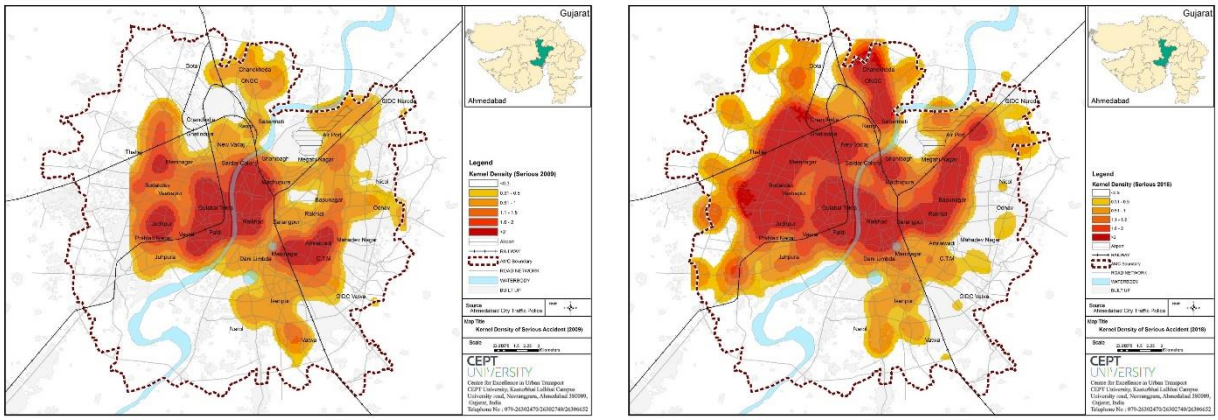
If we see the spatio-temporal variation in the road crash locations over the years and compare the numbers for 2009 and 2018 (refer to Figure 28), it is seen that fatal road crashes are further intensifying in the eastern part of the city, with a few new hotspots emerging in the west along the Sarkhej–Gandhinagar (SG) Highway and in New Vadaj.



Fatalities Hotspots 2009 **Fatalities Hotspots 2009**

Figure 28: Spatial Distribution of Fatalities Hotspots 2009 and 2018

However, in the case of serious road crashes (see Figure 29), the denser clusters are seen in both the eastern and the western parts of the city along the arterial roads, especially the newly developing areas such as Chandkheda towards the north of the city, along SG Highway and 132 Feet Ring Road. An intensification of road crashes resulting in serious injuries is also seen in the core city area.

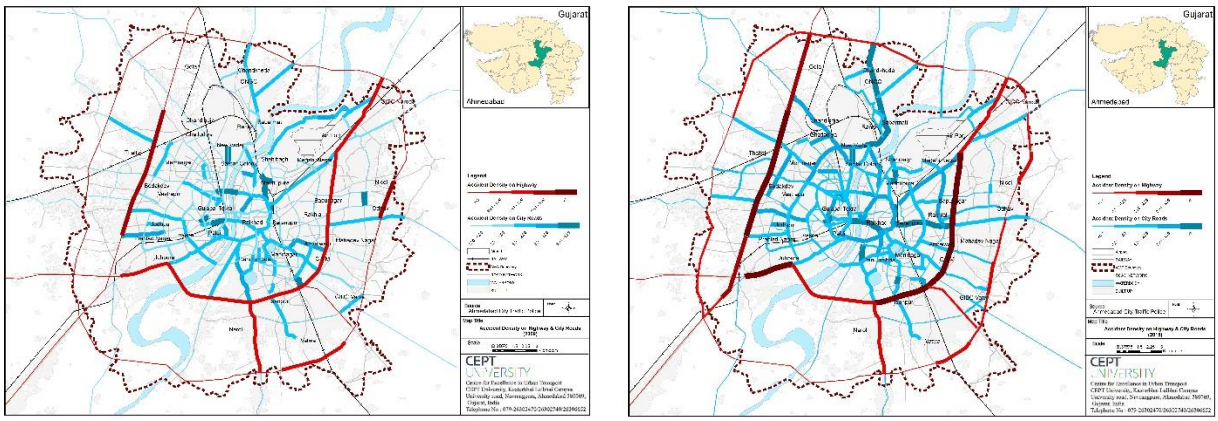


Serious Injuries Hotspots 2009 **Serious Injuries Hotspots 2018**

Figure 29: Spatial Distribution of Serious Injuries Hotspots 2009 and 2018

4. Road Crashes along Urban Roads and Highways

Looking at the concentration of hotspots, major road crash prone corridors (road crashes per km) were identified (see Figure 30). Though the overall average speeds in the city are not very high (28 kmph), high speeds were observed on some of the road crash prone corridors like SG Highway and 132 Feet Ring. Almost 85 percent of the total fatal and serious road crashes occur along these stretches, which is an increase of almost 30 percent from the 2009 level. It is seen that the road crash density per km of road is above 3 in the case of SG Highway in the west and the Inner Ring Road, especially on the eastern side of the city. In terms of the urban roads, intensification of road crashes (increase in the road crashed per km) is seen along the 132 feet ring road near Odhav and Chandkheda. On comparing the 2009 and 2018 data, it is evident that intensification of road crashes has occurred along highways as seen in Figure 7 below:



Road Crash Density 2009 **Road Crash Density 2018**

Figure 30: Comparison of Road Crash Prone Roads 2009 and 2018

5. Affected and Responsible Modes

Affected modes are defined as the modes that are at the risk of fatalities and serious injuries during a road crash. Pedestrians (including public transport users) and two-wheeler users emerge as the most affected user group in 2018, with 42 percent and 39 percent fatalities belonging to these groups. It is seen that the overall proportion of these two groups alone has risen by 9 percent since 2009. On comparing the data for 2009 and 2018, it is observed that the proportion of pedestrian fatalities occurring during the day (5am to 8pm) has reduced from 71 percent in 2009 to 61 percent in 2018. On the other hand, fatalities occurring during the night (8pm to 5am) have increased from 29 percent in 2009 to 34 percent in 2018. It is also seen that the proportion of cyclist fatalities reduced from 14 percent to 4 percent. However, it should also be noted that the mode share of cyclists in the city is low at 9 percent, as per a survey conducted in 2012.

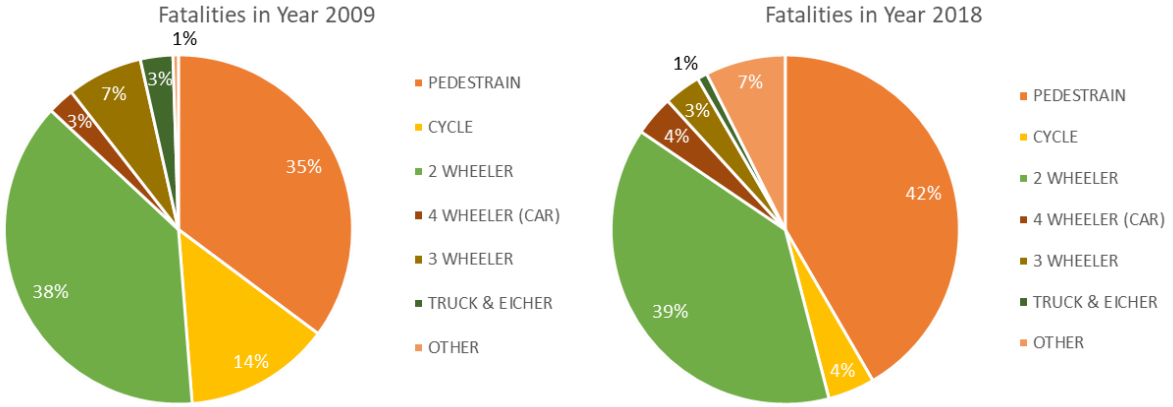


Figure 31: Comparison of 2009 and 2018 Affected Modes for Fatalities

In the case of serious road crashes, two-wheeler users (49 percent) and pedestrians (41 percent) as affected modes account for almost 90 percent of the total injuries, the numbers have increased by about 10 percent when compared to the data from 2009 (see Figure 32). Even though the proportion of pedestrians has remained the same, it is still very high in terms of the sheer number. Apart from poor pedestrian facilities in the city, poor lux levels as indicated by LOS 4 (Ministry of Housing and Urban Affairs, 2016a) on city roads may also contribute to high number of fatalities and serious injuries during night time. On the other hand, two-wheeler users have become more vulnerable, with their proportion in serious injuries increasing from 39 percent in 2009 to 49 percent in 2018. The proportion of cyclists has reduced by half due to a decline in cycle users across the city; the absolute number however is still high. The use of two-wheelers offering speed, flexibility and door-to-door service is increasing at a fast rate. However, safety of this transportation mode still remains a question, given the poor adherence to traffic norms by users and non-compliance of the helmet wearing rule.

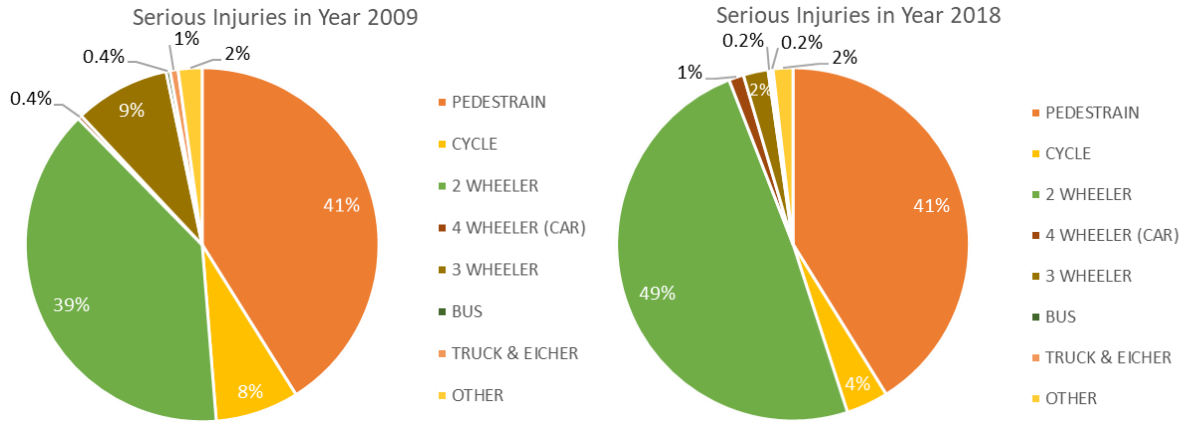
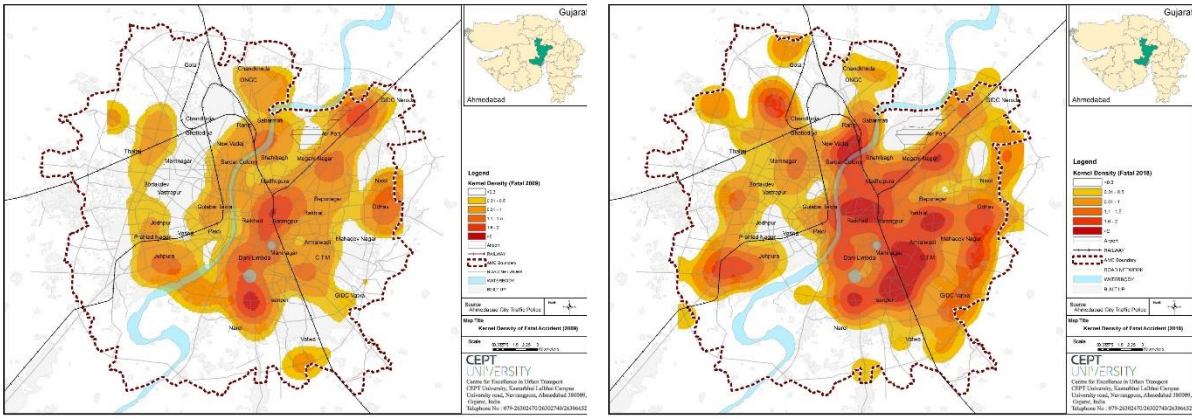


Figure 32: Comparison of 2009 and 2018 Affected Modes for Serious Injuries

Spatial distribution of pedestrian fatalities and serious injuries indicates that the spatial extent of the same, which was mostly concentrated in the old city areas and small pockets near Narol in 2009, has now spread throughout the city (refer to Figure 33). The eastern side of the city is impacted more as compared to the western one, owing to the dominance of low-income households, with walking being the predominant mode of travel. Newly developing areas towards the outskirts of the city have emerged over the years as new hotspots of fatality and serious injury prone areas. It is also seen that while high concentration of fatalities and serious injuries in the Old City area was concentrated near the railway station in 2009, it has now spread to cover most of the Old City areas. Apart from this, the incidence of fatalities in areas near Nava Vadaj, CTM (Calico Textile Mill) and Bapunagar has worsened. Only 16 percent of the city is covered with footpaths of width 1.8 meters and above. Besides, only 41 percent of the junctions are signalized and, of these, almost 39 percent have signalized intersection delays. Hence, poor pedestrian facilities in the city with overall LOS of 3 contribute to the vulnerability of pedestrians in the city (Ministry of Housing and Urban Affairs, 2016b).



Pedestrian Fatalities and Serious Injuries 2009 **Pedestrian Fatalities and Serious Injuries 2018**

Figure 33: Distribution of Pedestrian Fatalities and Serious Injuries 2009 and 2018

If we look at the responsible modes that contribute to road crashes, it is observed that private motorized vehicle cars (26 percent) and two-wheelers (25 percent) contributed to about 41 percent of the fatalities in 2018 (refer to Figure 34). Apart from these, freight vehicles also contributed a significant 23 percent of fatalities in the same year. When compared to the 2009 numbers, the road crash trend indicates that the fatalities due to private mode of vehicles (two-wheelers and four-wheelers) are on the rise. However, within the privatized modes, fatalities in the case of two-wheelers have more than doubled in the last 10 years. In the case of cars, the number has almost doubled. On the other hand, fatalities by freight vehicles in the city are on a declining trend and has almost halved. This reduction could be attributed to the efforts made by the city authorities in terms of imposing restrictions on the movement of heavy vehicles in the city during morning peak hours (9am to 1pm) and evening peak hours (4pm to 9pm).

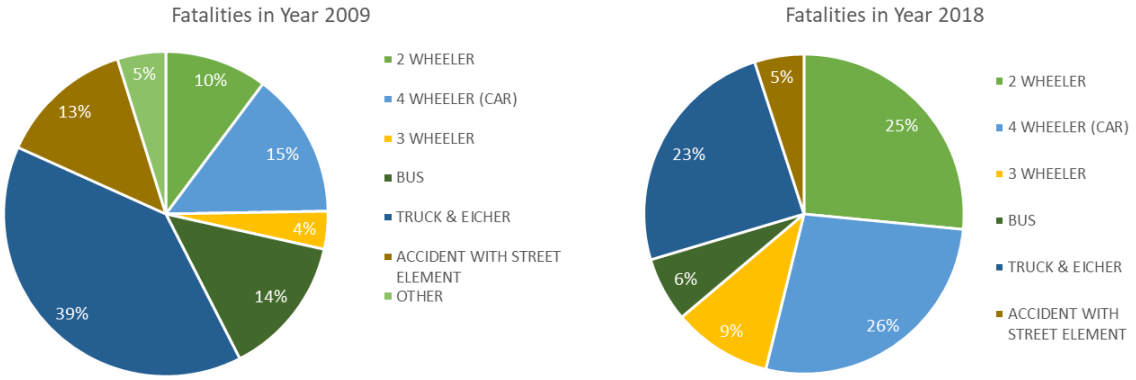


Figure 34: Comparison of 2009 and 2018 Responsible Modes for Fatalities

However, in the case of serious injuries, it is observed that 73 percent of the total serious injuries were attributed to cars and two-wheelers in 2018 (refer to Figure 35). It is seen that the private vehicles (cars and two-wheelers) have been growing at the rate of about 11 percent annually. As of 2012, about 25 percent of the total trips in the city were carried out on two-wheelers and only 4 percent on four-wheelers. Hence, the increase in both fatalities and serious injuries attributed to private vehicles is a matter of concern, especially in the case of four-wheelers, which have registered an increase in both fatal (63 percent) and serious injuries (43 percent) despite having a smaller proportion in the mode share. Reduction in road crashes due to street elements has also been observed. It could be attributed to road design improvement made by the city authorities. However, in terms of absolute numbers, road crashes due to street elements is still high.

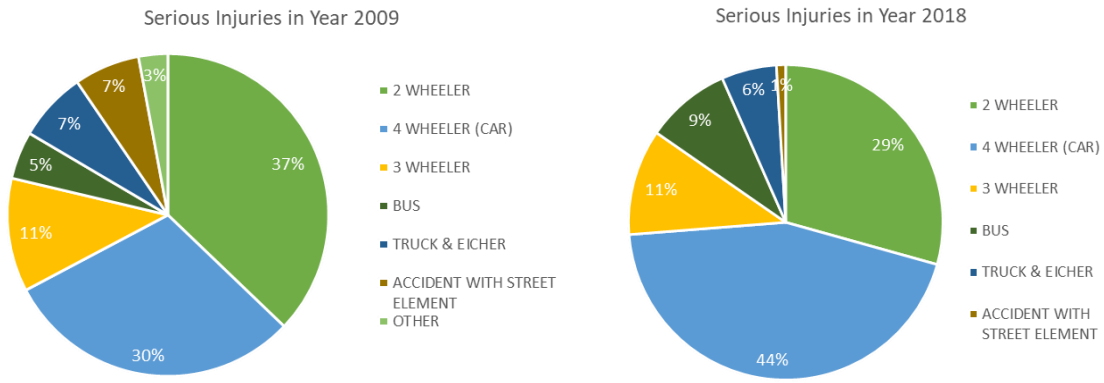
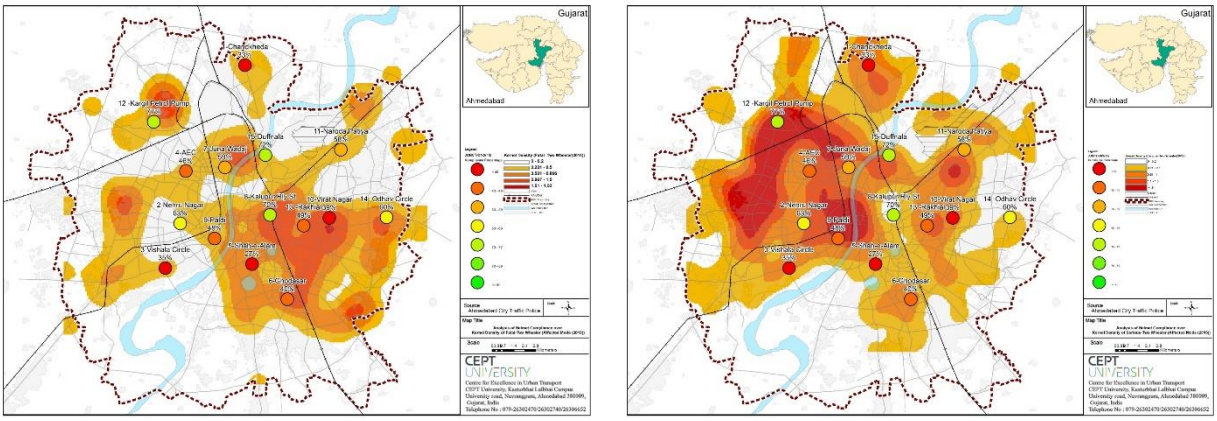


Figure 35: Comparison of 2009 and 2018 Modes Responsible for Serious Injuries

Increase in motorization, especially two-wheelers, is most evident in the South East Asian region. Studies have indicated that two-wheeler users are among the most vulnerable group in terms of fatalities and serious injuries attributed to traffic road crashes (World Health Organisation, 2015).

A recent research on compliance levels in the city on helmet usage indicates that almost half of the two-wheeler users do not wear one. The study covered 15 locations across the city and indicated that the overall compliance level in the city is at 53 percent (Centre of Excellence in Urban Transport, CRDF, CEPT University, 2019). Some of the locations, such as Kargil Petrol Pump along the SG Highway, Kalupur Railway Station and Dafnala along Airport Road, with high fatalities are found to have high compliance in 2019 owing to strict enforcement of helmet use. This may aid in bringing down fatalities at these locations (refer to Figure 36).



Two-wheeler Fatal Road Crashes 2018 **Two-wheeler Serious Road Crashes 2018**

Figure 36: Helmet Use Compliance and Two-wheeler Road Crashes

6. Prioritizing Road Crash Hotspots for Safety Action Plan

Identification and ranking of the road crash hotspots are important to prioritize resources for a safety management plan. Hence, using the cluster analysis technique, spatial location of road crashes that occurred between 2009 and 2018 were analyzed by classifying them into junctions/ intersections and mid-blocks. Results have revealed 64 hotspots locations in Ahmedabad where fatalities and serious injuries have occurred over the last 10 years (refer to Figure 37). These were further classified as per intensity as: severe locations (7–11 fatalities and serious injuries), moderately severe (11–21 fatalities and serious injuries), most severe (21–32 fatalities and serious injuries) and extremely severe (32–39 fatalities and serious injuries) locations. It was found that these locations alone contributed to about 22 percent of the total road crashes in the city. Of these, 48 locations are junctions and 16 are mid-blocks. Amongst the junction locations, almost 50 percent of them are non-signalized junctions on major arterials.

The top ten road crash locations include seven junctions and three mid-block locations: Vadaj, between Narol and Aslali junction (2), Narol Junction, Sarangpur Circle, Iskon Junction, between Narol and Aslali junction (1), Swastik Cross Road, Ellis Bridge, RTO and Aarvee Denim. These locations can be helpful in prioritizing the interventions.

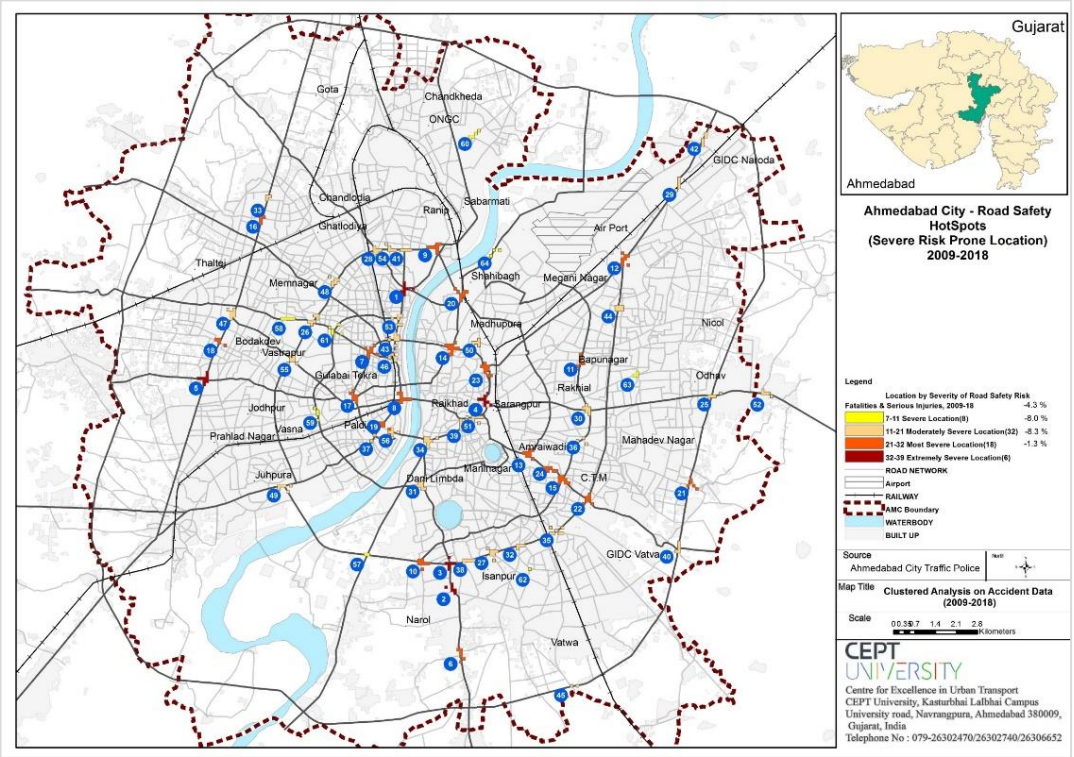


Figure 37: Road Crash Hotspots in Ahmedabad 2009 to 2019

7. Initiatives Taken by the Traffic Police to Improve Safety

The results of the road crash analysis were discussed with the Traffic Police Department to help them devise a safety action plan for the city. As per the discussions, it was found that the city authorities have taken up various initiatives to improve road safety. These include more vigorous enforcement of traffic rules. In this regard, traffic surveillance cameras that were installed as a part of the Smart City Mission are now being used to issue E-challan (online traffic violation penalty system) to the offenders especially in the case of stop line violation. According to the authorities, this alone has resulted in behavioural changes in the drivers who are generally seen to be abiding by regulations, especially in areas where traffic cameras have been installed.

Furthermore, safety drives on helmet use have also been carried out across the city and this has resulted in city-wide improvement of helmet rule compliance. It is expected that this will also result in reduction in two-wheeler fatalities and serious injuries in the city. Another development has been that junction improvements have been made a priority and efforts by the Traffic Police Department are underway to improve road junction design by measuring line of vision and blocking the traffic conflicting points on highways during peak hours. The Iskcon Junction, Bodakdev Crossroad have recently seen these measures being implemented. Additionally, efforts have also been made by the Traffic Police Department to keep road traffic signals working for 24 hours at major junctions to minimize collisions in the city.

The traffic authorities have already imposed restrictions on the entry of heavy vehicles which has resulted in reduction in freight related road crashes. Entry restrictions between 7am and 11pm are also in place now for long distance private bus operators in the city. Plans are also being prepared to revise speed limits on highways that pass through the city.

Ahmedabad has also introduced the BRT (bus rapid transport) as a public transport mode to discourage use of personal vehicles, along with investments along the entire street with focus on providing pedestrian facilities. On the promotional side, initiatives such as car-free day have also been introduced to bring back the focus on pedestrians. However, more will have to be done in terms of managing the

growth of privatized vehicles in the city to see reductions in fatalities and serious injuries in the longer run.

8. Conclusions and Learnings

Analyzing road crashes data for Ahmedabad revealed that road crashes in the city are increasing and the overall road crashes per hundred thousand population is high at 3.8. Exposure of the working age group (18 to 60 years) to road crashes including fatalities also indicates a serious issue. Research conducted by the World Health Organization in the South East Asian region suggested that the indirect cost of RTI (road traffic injuries) is high and it imposes a great burden on not only individuals but also families and the government. It also estimated that about 2 percent of the GDP is lost due to road traffic injuries in India alone (Aeron , Jacob , Sexton, Gururaj, & Rahman, 2004). The vulnerability of the poor in developing countries is also underlined as they are exposed to unsafe traffic environment and are unable to afford healthcare (World Health Organisation, 2015).

Pedestrians and two-wheeler users have emerged as the predominant affected mode users. Poor pedestrian facilities across the city remain as one of the predominant reasons behind pedestrian fatalities and serious injuries. Two-wheeler users have replaced cyclists due to reduction in their overall numbers over time. Tackling the issue of two-wheelers as a choice mode (owing to the flexibility it provides and the sheer number of users in the city) will remain a difficult challenge to manage.

On the other hand, in terms of contributing modes towards road crashes, the dominance of heavy freight vehicle as a responsible mode is no longer observed. It is cars which have now become the predominant contributor to fatalities across the city. The growing trend of cars in the city in conjunction with poor traffic regulation adherence has become a pressing issue. Today, although cars as a transportation mode have become safer for car drivers, the on-street behaviour of the car users' requires attention. Hence, ways to reduce car use and calm vehicle speeds will need to be explored.

While the proportion of fatalities and serious injuries as a result of road crashes attributed to poor street elements has reduced in the city from 9 percent in 2009 to 2 percent in 2018, their absolute number (17 in 2018) is still high.

The above trend is not restricted to just Indian cities—in fact urban areas of most of the developing countries in South East Asia are struggling with similar issues, especially given the high prevalence of two-wheelers. In this context, helmet use and adhering to traffic rules assumes paramount significance. Ahmedabad is known for poor adherence to traffic laws. However, the introduction of video surveillance under the Smart City Mission has been helpful in improving the overall adherence to traffic regulation in the city. In line with the efforts to improve road safety, the city police authorities have initiated the online traffic violation penalty system for road traffic violations in 2016, to compel wider public use of helmets and safety belts while driving. E-surveillance has resulted in changing driver behaviour for the better in most parts of the city. It was also seen that continuous enforcement of regulations, such as wearing helmets and seat belts, has also resulted in improvement in user behaviour in areas where the enforcement drives were carried out as compared to areas where they were not.

Highways passing through Ahmedabad have high incidence of fatal and serious road crashes. High speeds coupled with intrusion of freight vehicles on these corridors seem to be the reasons for this. Even though the traffic police have been able to reduce road crashes as a result of entry restrictions for freight vehicles in the city to almost half, more needs to be done in this regard. Speed restrictions enforcement could help significantly towards reduction in the quantum of road crashes. This should be supplemented by a more stringent overall enforcement of traffic regulations as a step towards ensuring greater road safety.

Techniques like hotspot analysis have provided 64 specific high-risk locations in the city which needs to be further investigated by the authorities. These locations become important from the perspective of reducing road crashes in the city—the city authorities can take up these locations on a priority basis to ascertain the exact cause of the road crashes along with enforcing the mitigating measures in these areas. Since resources are a constraint in most of the developing cities across the world, this technique can be helpful in devising an effective and economical road crash reduction plan for the city. Simple measures like signalization, speed restrictions, improvement in pedestrian facilities and lux levels could go a long way in reducing the overall incidence of road crashes in the city. However, focus on public

transportation modes and discouraging the use of personal private vehicles will remain the substantial measure if significant reductions in road crashes are to be seen.

References

Aeron , T. A., Jacob , G., Sexton, B., Gururaj, G., & Rahman, F. (2004). *The Involvement and Impact of Road Crashes on the Poor: Bangladesh and India Case Studies.* Retrieved from http://r4d.dfid.gov.uk/pdf/outputs/R7780.pdf

Bailey, T., & Gatrell, A. (1995). *Interactive Spatial Data Analysis.* Routledge.

Centre of Excellence in Urban Transport, CRDF, CEPT University. (2019). *Helmet Use Compliance.* Ahmedabad: Unpublished.

iRAP. (2019a). Retrieved from iRAP Web site: https://www.irap.org/

iRAP. (2014). *iRAP Methodology Fact Sheet1: Overview.* Retrieved from iRAP Web site: http://resources.irap.org/Methodology/iRAP%20model%20factsheet%201%20-%20Overview.pdf

iRAP. (2015). *iRAP Methodology Fact Sheet3: Road Attributes.* Retrieved from iRAP Web site: http://resources.irap.org/Methodology/iRAP%20model%20factsheet%203%20-Road%20attributes.pdf

iRAP. (2013). *iRAP Methodology Fact Sheet4: Crash Types.* Retrieved from iRAP Web site: http://resources.irap.org/Methodology/iRAP%20model%20factsheet%204%20-%20Crash%20types.pdf

iRAP. (2019b). *iRAP Specification, Manuals and User Manual Update.* Retrieved from iRAP Web site: http://resources.irap.org/Specifications/iRAP_Coding_Manual_Drive_on_Left.pdf

iRAP. (2017). *New Indian Road Assessment Programme to Save Lives*. Retrieved from iRAP News: https://www.irap.org/2017/11/new-indian-road-assessment-programme-to-save-lives/

iRAP. (2018). *The Business Case for Safer Roads*. Retrieved from Vaccines for Roads IV: https://www.vaccinesforroads.org/business-case-for-safer-roads/

ITF. (2016). *Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System.* Paris: OECD.

JPRI. (2012a). *iRAP Baseline Data Collection in India, Final Report - Karnataka Phase.* Coimbatore.

Kar, K., & Datta, T. K. (2009). An Overview of Mobility and Safety Issues Related to Highway Transportation in India. *ITE Journal* , 40–45.

Ministry of Housing and Urban Affairs. (2016b). *Service Level Benchmarking for Indian Cities – Round 2.*

Ministry of Housing and Urban Affairs. (2016a, March 19). *Vision and Mission*. Retrieved March 21, 2016, from Department of Food and Public Distribution: http://dfpd.nic.in/

Ministry of Road Transport and Highways Government of India. (2018). *Road Accidents in India – 2017.* New Delhi: Government of India.

MoRTH. (2018). *Road Accidents in India - 2017.* New Delhi: Transport Research Wing, Ministry of Road Transport and Highways Govt. of India.

MoRTH. (2008). *Road Accidents in India.* New Delhi: Government of India.

NCRB. (2015). *Accidental Deaths and Suicides in India 2014.* New Delhi: National Crime Records Bureau, Ministry of Home Affairs.

Office of the Registrar General & Census Commissioner, India. (2011). *Town and Village Directory.* New Delhi: Government of India.

Sharief, M., & Reddy, K. (2018). Implementation of Safe Corridor Demonstration Program in Stretch of SH-20 from Yaragatti to Belgaum. *Journal of the Indian Roads Congress , 79-3*.

Transport Department Government of the Hong Kong Special Administration Region. (2017). *www.td.gov.hk*. Retrieved March 22, 2019, from https://www.td.gov.hk/filemanager/en/content_4909/f_a1.pdf

UNESCAP. (2016). *Asian Highway Design Standards For Road Safety Annex-II bis.* Retrieved from UNESCAP Intergovernmental Agreement on the Asian Highway Network: https://www.unescap.org/sites/default/files/AH%20Design%20Standards%20for%20Raod%20Safety%20-%20Adopted%20Annex%20II%20bis.pdf

WHO. (2018). *Global Status Report on Road Safety.* World Health Organization.

World Bank. (2011). *Project Appraisal Document for the Second Karnataka State Highway Improvement Project.* Retrieved from World Bank: http://documents.worldbank.org/curated/en/827871468042298605/pdf/590890PAD0P10710only1910BOX358303B0.pdf

World Bank. (2013). *Second Gujarat State Highway Project*. Retrieved from The World Bank: http://projects.worldbank.org/P114827/gujarat-state-highway-project-ii?lang=en

World Health Organisation. (2018). *Global Status Report on Road Safety.* Geneva: WHO.

World Health Organisation. (2015). *Research Framework for Road Safety in the South East Asia Region.* Retrieved June 15, 2019, from https://apps.who.int: https://apps.who.int/iris/handle/10665/160763

Road Accidents in India: Need for Post-Accident Health Care Facilities

Absar Alam

ABSTRACT

The paper attempts a causal analysis of road traffic accidents and related deaths with other macroeconomic indicators like per capita expenditure on health, motorization and urbanization, etc. using panel data regression for analyzing data from all Indian states. The findings reveal that public expenditure on health services significantly and negatively affect fatalities in road crashes. This implies that there is a need for post-accident health care facilities in most of the Indian states. It also establishes the fact that road crashes and fatalities on national highways attract special attention, especially the roads passing through rural areas. The study also highlights that there are states with relatively lower number of road accidents and higher number of deaths per accident. These states need policy measures in respect of post-accident health care facilities. States with larger share in road accidents and related fatalities are equally important. The paper recommends for increasing expenditure on services like public transport and public health.

Key words: Transportation system, Safety and Accidents, Road Safety, Road Accidents, Accidental Deaths and Expenditure on Road Safety

1. Introduction

Road accident is one of the leading causes of deaths worldwide. Global status report of the year 2018 on road safety, published by World Health Organization (WHO), highlights this fact. The report says that almost 1.35 million people died in road crashes in 2016. In the same year, road crashes emerged as the 8th largest cause of deaths in the world with 2.5 percent share in total deaths caused by all kind of diseases. This is almost the same scale of deaths caused by HIV/AIDS (WHO, 2018 and 2014). In India, total number of deaths due to road traffic crashes was estimated to be 147,913 in 2017 (MoRTH, 2017). Number of fatalities in road crashes increased by about ten-folds against the increase of total number of crashes by merely four-folds during the period from1970 to 2017 (MoRTH, 2017).

Demographic classification suggests, population below 35 years of age constituted more than 56 percent of the total deaths in road crashes (MoRTH, 2017), affecting the very young population of the country. Recognising this as a global threat, the member countries of the United Nations (UN) agreed to reduce the number of fatalities in road crashes by bringing it into the global commitments as enlisted in the Sustainable Development Goals (SDGs). Goal 3 of SDGs focuses on good health and well-being. Besides, the objective includes reducing the global deaths and injuries in road crashes by half during the next five years. This goal is directly linked with the road crashes. In addition to the goal 3.6, goal 11 of the SDGs advocates about sustainable cities and communities having indirect impact on road crashes.

Goal 11.2 stresses on the commitments to "*provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons".*

By 2030, these goals must be achieved. Goal 10.7 of SDGs aims at reducing inequality by "facilitating orderly, safe, regular and responsible migration and mobility of people, including the implementation of planned and well-managed migration policies". Keeping in mind, these direct and indirect SDGs, countries have pledged to tackle road crashes by adopting strategies and policies.

Based on the defined targets under SDGs, member states of the UN reached a consensus on the following 12 voluntary global performance targets on road safety risk factors and service delivery mechanism (WHO, 2018);

1. By 2020, all countries establish a comprehensive multi-sectoral national road safety action plan with time-bound targets.

2. By 2030, all countries accede to one or more of the core road safety-related UN legal instruments.
3. By 2030, all new roads must achieve technical standards for all road users that take into account road safety, or meet a three-star rating or better.
4. By 2030, more than 75 percent of travel on existing roads is on roads that meet technical standards for all road users that take into account road safety.
5. By 2030, 100 percent of new (defined as produced, sold or imported) and used vehicles meet high quality safety standards, such as the recommended priority UN Regulations, Global Technical Regulations, or equivalent recognized national performance requirements.
6. By 2030, halve the proportion of vehicles travelling over the posted speed limit and achieve a reduction in speed related injuries and fatalities.
7. By 2030, increase the proportion of motorcycle riders correctly using standard helmets to close to 100 percent.
8. By 2030, increase the proportion of motor vehicle occupants using safety belts or standard child restraint systems to close to 100 percent.
9. By 2030, halve the number of road traffic injuries and fatalities related to drivers using alcohol, and/or achieve a reduction in those related to other psychoactive substances.
10. By 2030, all countries have national laws to restrict or prohibit the use of mobile phones while driving.
11. By 2030, all countries to enact regulation for driving time and rest periods for professional drivers, and/or accede to international/regional regulation in this area.
12. By 2030, all countries establish and achieve national targets in order to minimize the time interval between road traffic crash and the provision of first professional emergency care.

The above listed targets were devised under five important pillars i.e. a) road safety management, b) safer roads and mobility, c) safe vehicles, d) safe road users and e) post-crash response. The target number 12 listed above comes under post-crash response that relates to post accident health and emergency care. This paper deals with this particular aspect of strategies to deal with fatalities in road crashes. The paper empirically investigates causal relationship between expenditure on health care facilities and number of deaths in road crashes. For this purpose, it presents a panel data regression analysis using different indicators like accidental deaths, expenditure on health facilities, number of buses, etc. for all the States and Union Territories (UT) in India. It is important to mention here that India is comprised of several provinces called States and UT.

The paper also investigates the trend of road accidents on national highways, state highways, rural and feeder roads in India.[14] This analysis includes the examination of state wise number of road accidents, persons killed in road accidents, and persons injured. This analysis will help finding the vulnerable states and areas where the government needs to intervene in post-accident healthcare facilities on priority level. In the next section, a brief review of existing literature is discussed.

2. Literature Review

There exist several studies on road accidents vital for strategies to tackle this serious problem. Some of the literature on road accidents has contradictory findings when compared to other researches carried out in this area. For instance, Agustus (2012) establishes that increase in the length of roads leads to the increase in road crashes. It concludes that the area with higher traffic volumes have higher rate of accidents as compare to the areas having low traffic volume. This finding is contradictory to Smeed's law. Smeed finds that increase in motorization level leads to increase in fatalities per capita and decrease in fatalities per vehicles (Smeed, 1949). While, Andreassen (1985) revisits this conclusion and finds that Smeed's proposition is not viable for all countries and has no universal application.

[14] Indian roads are classified into five categories i.e. national highways, state highways, other PWD roads, rural roads, urban roads and project roads. National highways are main interregional/inter-provincial roads financed and managed by the Central Government. State highways are intra-provincial roads financed and managed by State Governments. PWD roads and rural roads are district roads connecting villages with district headquarters and other villages.

Kopits and Cropper (2005) studied 88 countries based on their macro level data. It establishes causal relationship between the total number of fatalities on fatality rates per unit vehicle, vehicles per unit population, and per-capita income and also makes a projection of the future level of fatalities in road crashes as a result of changes in the level of income, population and motorization.

Some of the researches on India highlight the causes of road crashes at national level. Findings establish that the higher the level of motorization, higher will be the incidents of road crashes. Pramada (2004) presents empirical analysis of causes and factors leading road crashes in India. The paper is, however, confined to earlier empirical models and factors dealing with motorization only. This study does not consider other factors like urbanization, road design, traffic control, speed of vehicle, etc.

Mohan and Tiwari (2000) conclude that pedestrians, bicyclists, and motorized two-wheeler riders accounted for 60-90 percent of all traffic fatalities. Mohan et al. (2009) present both macro and micro level causes of accidents based on the city level data. They conclude that the pedestrians and users of non-motorized transport are more vulnerable as they are more exposed to road accidents than other road users. According to time, night time exposure of accidents on roads are lower than that of day time, yet night time crashes has higher share in fatalities (Tiwari et al. 1998). Indian cities with higher slow-moving traffic are unsafe due to absence of separate carriageway or lane for slow-moving traffic (Wilbur Smith Associates, 2008). The study also highlights the need for better traffic management in smaller and medium cities which have potential to reduce traffic crashes.

Rapid motorization, lack of adequate design in road construction and driver's behaviour like drunk driving are among the leading causes of road crashes. In addition, other causes include lack of safety policies and measures as well as absence of coordination among government departments and road users. Kharola et. al (2010), based on crashes by buses, highlights factors leading to road accidents which includes bus design, absence of road crossing for pedestrians, lack of infrastructure for non-motorized transport, etc. This research also suggests that 71 percent of the total road crashes were two wheelers victims and were travelling in the same direction of buses. The case of cyclist is almost the same. It suggests the need for separate lanes for two wheelers and cycle users.

Revisiting the causes of traffic accidents in India, Grimm and Treibich (2012) empirically examined the causal relationship of road fatalities with macroeconomic indicators such as income, motorization and urbanization. Using panel data approach with data from 1989 to 2006, the study applies two-way fixed effect models on the sample data for 26 states and UTs. The results established positive relationship between fatalities in road crashes and factors like motorization, urbanization and income. The study found that expenditure per policeman has significant and negative effect on road crashes suggesting higher the expenditure on policemen, lower the level of road crashes. However, a gap exists in literature examining causal relationship between expenditure on health services and fatalities in road crashes. This gap is partially filled by Garg and Hyder (2006). This study found that absolute burden of fatalities in road crashes is increasing in India and therefore recommended the arrangement of post-accident health care facilities. Notwithstanding, there remains a gap in literature investigating relationship between expenditure on health services and deaths in road crashes. The current paper tries to fill this research gap. Its findings are likely to help policy makers in planning and executing strategies to tackle the issue of road crashes and resultant fatalities.

3. Data and Method

Two analytical dimensions are presented in this paper. First dimension outlines the current state of road accidents in India- at both national and regional levels. For analysis, the accidents related data was obtained from the Ministry of Road Transport and Highways, Government of India. The Ministry publishes annual data for road accidents which is available up to the year 2017. However, this paper presents an analysis of status on road accidents in India for the years 2006 to 2016. The paper also presents road accidents status in rural and urban areas using data for the period from 2006 to 2015 owing to the non-availability of latest data in this category. Data from the annual reports of the Ministry is the only source of data on road accidents in India. These reports have also provincial data of different years. There are no other sources of such data at state/provincial levels. Therefore, data from the Ministry is suitable for our analysis. However, one must be familiar with the fact that these data are collected by National Crime and Research Bureau (NCRB) based on reports to the agencies like police reports. There are possibilities of data variations between Government and other agencies.

The second dimension presented in this paper is related to post accidental health care facility through a panel data regression analysis. This exercise is based on causal relationship between variables like road crashes and resultant fatalities and per capita income, motorization and planned expenditure in health sector. Data related to road crashes and fatalities was collected from the Ministry of Road Transport and Highways for the period of 2002-12.

This data is further normalized based on population data of all the States and UTs on the basis of growth rates between the 2001 and 2011- the years of two censuses. Data on motorization i.e. increase in the numbers of motor vehicles were obtained from annual reports published by the Ministry for the period 2002-12. Per capita Net State Domestic Product (NSDP) at current price based on 2004-05 base year and per capita planned expenditure on health were calculated based on data from Reserve Bank of India (RBI) and Planning Commission (now NITI Aayog), Government of India, respectively. State wise density is taken from census data of 2001 and 2011 and estimated the same for the rest of the years based on the decadal growth for each state.

A panel data analysis was undertaken in the study using basic regression model as described in equation 1. This equation is further augmented with relevant variables incorporated therein as per equation 2.

$Y_{it} = \alpha_i + \beta_1 X_{it} + u_{it}$ ---------- (eq. 1)

Where,

α_i (i=1....n) is the unknown intercept for each entity.

Y_{it} is the dependent variable where i= entity and t= time

X_{it} represents one independent variable.

β_1 is coefficient for the independent variable.

u_{it} is the error term.

Number of accidents/100,000 population= $\alpha + \beta_1 X + \beta_2 X_1 +$ ------$+X_8+\mu$----------(eq. 2)

In case of fatalities in road crashes per 100,000 population we have used the same independent variables.

Where,

X **=** Per capita planned expenditure on health

X_1 = Per capita income

X_2 = Urbanization (Urban population as percent of total population)

X_3 = Population density

X_4 = Motorization (total motor vehicle/1000 population)

X_5 = Level of two wheelers penetration (total two wheelers/1000 population)

X_6 = Trucks/1000 population

X_7 = Buses/1000 population

X_8 = Cars/1000 population

Variables described in equation 2 were used for States and UTs except UTs like Daman and Diu, Dadar and Nagar Haveli and Lakshadweep. The data for expenditure on health-related services for 2011 and 2012 are approved outlay whereas for the years prior to 2011 are actual expenditure. This exercise is not extended beyond 2012 due to the fact that the data on state-wise planned expenditure on health was not available. This is noted here that the Government of India has abolished planning in the year 2014. Therefore, expenditure data has huge differences owing to the fact that now expenditure on health includes both planned and non-planned expenditure. On the other hand, the Government has also revised its base year from 2004-05 to 2011-12 which has made the recent year income data not compatible to the data prior to 2012.

4. State of Road Accidents in India

Increase in the number of road crashes in India call for an adequate strategies and policy interventions. There is a need for systematic method for data collection on road accidents. As highlighted earlier that the statistics are based on the incidents of accidents reported to the NCRB. Thus, a constraint exists before devising policies and strategies for safety related measures using the data used for the current research. Yet, despite the constraints of this data and discrepancies associated with it, National Transport Development Policy Committee (NTDPC) has formulated long term strategies to tackle accidents for all modes of transport including Airways, Railways, Waterways and Roads using the same data and sources. However, the report by the committee calls for appropriate statistical system on creating database on road accidents (NTDPC, 2014). The report also proposed a post-accident safety measure. This is termed as Golden Care Initiative to ensure emergency medical facilities in the event of road accidents.

In India, increase in the number of deaths in road crashes has been striking against the increase in the number of road crashes. Surprisingly, total number of road crashes was increased at compound annual growth (CAGR) of 0.4 percent during 2006-2016 whereas the number of resultant deaths was increased at CAGR of 3.6 percent (MoRTH, 2017). This suggests that the rate of increase in number of fatalities is higher than the number of accidents. Total number of road crashes increased from 460.92 thousand in 2006 to 480.65 thousand in 2016. At the same time, number of fatalities increased from 105.75 thousand in 2006 to 150.79 thousand in 2016. Similarly, rate of deaths per 100 accidents increased from 23 in 2006 to 31 in 2016. The case of deaths per 100 injured persons follows almost the same trend. Comparing the statistics for the year 2015 and 2016, total number of accidents came down from 501.42 thousand in 2015 to 480.56 thousand in 2016 but the number of deaths increased from 146.13 thousand in 2015 to 150.79 thousand in 2016 (table 1). This trend clearly indicates that separate strategies are needed for tackling road crashes and also deaths in road crashes.

Table 1: A Summary of Road Accidents Scenario in India

Years	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Number of Accidents	460920	479216	484704	486384	499628	497686	490383	486476	489400	501423	480652
Number of Deaths	105749	114444	119860	125660	134513	142485	138258	137572	139671	146133	150785
Number of Injured	496481	513340	523193	515458	527512	511394	509667	494893	493474	500279	494624
Number of Deaths per 100 Accidents	23	24	25	26	27	29	28	28	29	29	31
Number of Deaths per 100 Injured	21	22	23	24	25	28	27	28	28	29	30
Number of Deaths per 100 Accidents (Rural)	26	27	28	30	31	34	32	32	32	33	35
Number of Deaths per 100 Accidents (Urban)	19	20	21	21	23	23	24	24	25	25	27
Number of Deaths per 100 Accidents on NH	28	29	31	32	32	35	34	33	35	36	37
Number of Deaths per 100 Accidents on SH	26	27	27	29	30	32	32	33	33	34	35

Source: Road Accident Statistics, Ministry of Road Transport and Highways, Government of India.
Note: NH is National Highways, SH is State Highways

Table 1 indicates that death rate is much higher on roads passing through rural areas and roads designated as National Highways. In 2006, deaths per 100 road accident was 26 in rural areas compared to 19 in urban areas. Similarly, the same statistics for rural areas was estimated to be 35 compared to 27 in urban areas in the year 2016. There is an increase in the death rate per 100 accidents in both rural and urban areas but this rate is higher in rural areas. Thus, a person meeting with crashes on roads passing through rural areas are more vulnerable to deaths compared to those who met with crashes on roads in urban areas. There is an obvious reason for this. Provision of trauma centres and medical emergency aid in rural areas are limited compared to urban areas.

Another important statistics is the rate of deaths on national highways and states highways. The death rate per 100 accidents on national highways increased from 28 in 2006 to 35 in 2011 and 37 in 2016. Deaths per 100 accidents on state highways is relatively low and estimated to be 26 in 2006 and 32 in 2011 and reached up to 35 in 2016. This indicates that the number of road crashes and number of fatalities are higher on both national and state highways but it is much higher on these roads if passing through rural areas. Therefore, national and state highways passing through rural areas need special attention in the context of providing post-accident health care facilities.

Rural population is more vulnerable to accidents. An empirical analysis is required to substantiate this. As of now, no such data is collected by the government differentiating the incidents of road accidents on rural roads, national highways and other roads passing through rural areas. However, the present data indicate that death rate in road crashes is high in rural areas particularly on in road crashes on national highways passing through rural areas.

5. Indian States Leading the Epidemic

States like Tamil Nadu, Maharashtra, Madhya Pradesh (MP), Karnataka, Kerala, Uttar Pradesh and Andhra Pradesh account for more than 64 percent of total accidents occurred in India in the year 2016. As a result, these states also account for more than 55 percent of the persons killed in road crashes in 2016. States with higher share of deaths in road crashes are Uttar Pradesh (13 percent), Tamil Nadu (11 percent), Maharashtra (9 percent), Karnataka (7 percent), Rajasthan (7 percent) and Madhya Pradesh (6 percent). These states have high share in both number of crashes occurred and fatalities. These states are the main areas of focus on how to mitigate road crashes and resultant fatalities.

Box 1: Best Practice in Post-Accident Health Care

The Supreme Court of India has constituted a committee on road safety under the chairmanship of Justice K S Radhakrishnan in January, 2019. The committee takes stock of new initiatives by state governments and also by other stakeholders. The committee also monitors the situation of road safety in the country. Tamil Nadu, a state of southern part of India, established a Tamil Nadu Accident & Emergency Care Initiative (TAEI). This organization started working with other agencies and has taken a coordinated effort to reduce the fatalities in road accidents. TAEI integrated 26 government medical college hospitals, 31 districts headquarter hospitals and 21 government hospitals working in strategic locations across the State. This coordinated effort led to the reduction in fatalities in road accidents by more than 24 percent. This effort was also lauded by Justice K S Radhakrishnan. He called all the states to adopt this model of Tamil Nadu.

Authorities identified deadliest points across the state having share of more than 40 percent of total fatalities in road accidents in Tamil Nadu. After identification of such spots, the TAEI analyzed data collected from the spot and positioned ambulances appropriately on selected routes. Public hospitals in the catchment area of the identified spots were equipped with required medical facilities. Thus, providing medical care in golden hour to those who met with accidents on the identified spots saved lives and reduced fatalities in road accidents substantially. In this way, Tamil Nadu is now a model state for post-accident health care facilities.
Source: The Better India, Published on June 24, 2019,
available at https://www.thebetterindia.com/186803/tamil-nadu-road-accidents-iit-supreme-court-

Number of deaths per 100 accidents at national level was 23 in 2006, which increased to 31 in 2016 (table 1 and table 2). The statistics also indicate that states like Mizoram, Punjab, Arunachal Pradesh and Uttarakhand recorded high number of persons killed per 100 road crashes (table 2). In 2016, 84 persons were killed per 100 road crashes in Mizoram, 73 in Punjab, and 66 persons killed per 100 road crashes in Jharkhand. States like Mizoram, Arunachal Pradesh, Uttarakhand and Nagaland are mountainous states with high rate of deaths per 100 road crashes. Some of the states like Jharkhand, Bihar, Punjab, Uttar Pradesh and West Bengal are situated in plain area having high deaths per 100 accidents.

The current status of road crashes and resultant fatalities in India suggests that multiple factors are influencing both crashes and fatalities. States, which are predominantly rural and mountainous, have high death rate while states with high urban and industrial clusters higher number of crashes but relatively lower death rate (Table 2). This suggests that these states save more lives in some or other way which may be similar to post accident health care.

Table 2: Deaths per 100 Road Crashes in Indian States

State/ UT	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lakshadweep	10	0	0	50	0		0	0	0	0	100
Mizoram	67	65	57	70	66	84	70	85	78	103	84
Punjab	62	65	63	66	64	76	76	73	72	73	73
Dadra and Nagar Haveli	44	57	56	57	65	61	62	54	68	61	66
Jharkhand	38	39	40	43	46	47	49	49	51	56	61
Nagaland	35	37	92	87	114	64	133	42	27	56	61
Uttarakhand	67	65	76	61	62	62	57	59	62	60	60
Arunachal Pradesh	52	40	48	52	51	48	55	46	58	45	60
Bihar	43	45	44	44	47	48	49	50	51	57	60
Uttar Pradesh	56	53	51	52	54	73	54	52	52	55	54
Daman and Diu	47	48	58	52	65	66	58	53	38	60	54
West Bengal	41	41	39	44	38	38	44	44	46	47	48
Rajasthan	31	34	35	36	38	40	41	41	42	44	45
Haryana	39	37	39	39	42	43	44	43	42	44	45
Odisha	36	37	38	40	41	40	40	42	41	41	42
Sikkim	37	35	40	15	38	26	35	28	29	32	40
Himachal Pradesh	32	33	31	37	36	35	38	35	39	36	40
Gujarat	20	21	21	23	25	27	28	30	34	35	37
Chandigarh	27	28	31	40	30	31	32	29	36	31	35
Assam	39	36	39	41	39	36	35	34	35	34	35
Andhra Pradesh	29	31	32	34	35	34	35	33	32	34	34
Maharashtra	15	15	16	16	17	19	20	21	21	21	32
Telangana									34	33	32
All India Average	23	24	25	26	27	29	28	28	29	29	31
Tripura	25	28	29	26	26	29	31	28	26	24	31
Chhattisgarh	20	21	23	22	22	21	23	25	29	28	29
Karnataka	18	19	19	19	21	20	21	23	24	25	25
Meghalaya	38	42	42	36	34	35	45	25	26	30	24
Tamil Nadu	20	20	21	23	24	23	24	23	23	23	24
Delhi	23	25	25	31	30	28	27	24	19	20	22
Madhya Pradesh	14	16	15	16	16	16	16	17	16	17	18
Jammu & Kashmir	18	16	18	19	17	17	17	15	17	16	17
Manipur	31	21	26	22	26	23	20	25	23	21	15
Puducherry	13	15	12	13	16	16	16	16	14	15	14
Kerala	9	9	10	11	11	12	12	12	11	11	11
Goa	8	8	8	8	7	7	7	6	7	7	8
Andaman and Nicobar Islands	14	13	12	12	9	7	11	20	11	9	7

Source: Author's Calculation based on Data from Ministry of Road Transport and Highways

6. Rural Urban Divide in Road Accidents

Generally, road crashes are closely and directly related to urbanization and motorization. However, road accidents in rural areas are increasing at higher rate than road accidents in urban areas in India. Data of recent years suggest that average annual growth in number of accidents in rural areas during 2006-15 was 1.13 percent as compared to 0.75 percent in urban areas. It may be noted that motorization is high in urban areas compared to rural areas. A state wise comparison on rural-urban scenario of deaths per 100 road crashes is presented in the figure 1.

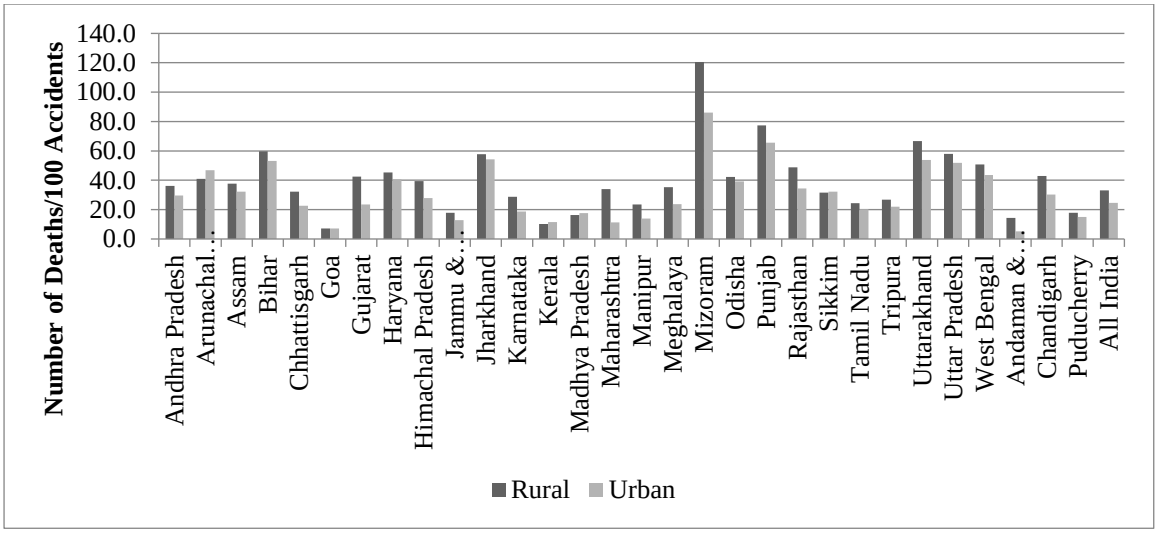


Figure 1: Rural and Urban Deaths per 100 Accidents in 2015
Source: Author's Calculation based on Data from Ministry of Road Transport and Highways

State-wise analysis would be critical to our purpose. On the one hand, some states are doing well in terms of minimizing causalities in road crashes in urban areas compared to rural areas. On the other hand, some states are not able to mitigate deaths per 100 crashes in rural areas. Tamil Nadu, Karnataka, Gujarat, Kerala, Madhya Pradesh, Punjab and Maharashtra have lower deaths per 100 accidents in urban areas. These states have higher deaths per 100 accidents in rural areas.

7. Results and Discussion

Table 3 presents descriptive statistics on which panel regression was performed. Before carrying out the specific regression analysis, it was examined whether the data was fit for this analysis or not. The panel data analysis was performed using STATA, a software for data analysis using statistical tools. Unit root test was run using Levin Lin Chu test and Fisher type in order to know that data is stationary or not. The test suggests that the panel data is stationary. For testing hetroskedasticity, Modified Wald test was carried out which shows that there is a presence of hetroskedasticity in the data. Wooldridge test on the data suggests that data do not have first-order autocorrelation. Using Hausman test, it was found that fixed effect was better than random effect model.

The result of the robust fixed effect regression is presented in table 4 and 5. Before analyzing the result of regression, it would be important to describe the features of the data to check out its co-linearity, heterogeneity and stationary in the panel. Our analysis is based on the model described in equation 2.

This exercise is based on ex-ante assumption that the prior studies have already established significant causal relationship of urbanization, motorization and per capita income with road accidents and the resultant fatalities. In the current analysis it was aimed at proposing some new findings apart from recognizing earlier research and their respective findings. The current paper incorporated additional variable i.e. per capita health expenditure, buses per 1000 population and cars per 1000 population, trucks per 1000 population, etc. To assess the causal relationship, accidents per 100,000 population and fatalities in road accidents per 100,000 population are taken as dependent variables and rest of other variables like per capita income, buses, trucks, cars, two wheelers, per capita income and expenditure on health are taken as explanatory variables. The purpose of the paper is to establish a statistically tested case for the provision of post accidental health care facilities. The results are described in table 4 and 5.

Table 3: Descriptive statistics of the observations

Variable	Observations	Mean	Standard Deviation	Min	Max
Number of accidents per 100,000 population	352	47.7857	47.7343	1.57	266.74
Number of persons killed in road accidents per 100,000 population	352	10.2649	4.66404	1.11	23.84
Per capita planned expenditure on health services	352	254.396	352.131	1.23	2436.85
Per capita income	352	33567.4	20661.2	5994	112626
Urbanization	352	33.5704	18.422	9.81	92.6
Population Density	352	975.41	2285.76	13.35	11514
Motorization	352	124.087	129.291	8.56	701.59
Two-wheeler per 1000 population	352	83.7065	95.039	5.35	501.69
Trucks per 1000 population	352	4.66105	5.33665	0.25	36.93
Buses per 1000 population	352	1.26997	1.62879	0.09	12.63
Cars per 1000 population	352	19.2858	32.3745	0.31	190.04

Source: Author

A fixed effect regression analyzes the effect of independent variables on the dependent variable by holding the average impact of each panel as constant. To decide between fixed or random effect models, Hausman test was carried out on the panel data. Finally, fixed effect robust model was used for panel data analysis which corrects the problem of heterogeneity.

Table 4 shows results of regression performed using different set of variable(s) as explanatory variable(s). Model 1 in the table 4 suggests that there is no significant and positive causal relationship between accidents per 100,000 population with per capita income. Model 2 in the table 4 incorporates more variables as explanatory variables making the data a larger set for analysis. The result of model 2 suggests significant and positive impact of per capita income on number of accidents per 100,000 population in India. As per model 2, there is a significant and negative impact of urbanization on accident per 100,000 population. Further enlarging the model by incorporating more variables as explanatory variables in model 3, which indicates that there is significant and negative relationship between accidents per 100,00 population and number of buses per 1000 persons and population density. This indicates that increase in public transport would result in decrease in the number of accidents.

Table 4: Fixed effect regression results of panel data (dependent variable = number of accident/ 100,000 population)

Description of Variable	Independent	Model 1	Model 2	Model 3
X_1	Per capita income	- 0.00000505 (0.962)	.0003 (0.030)**	.0002 (0.028)**
X_2	Urbanization (percent)		.477 (0.505)	.817 (0.138)
X_2	Population Density		-.016 (0.035)**	-.018 (0.011)**
X_4	Total Motorization per 1000 population		-.084 (0.181)	-.036 (0.159)
X_5	Two-wheeler per 1000 population			-.084 (0.372)
X_6	Trucks per 1000 population			.140 (0.872)
X_7	Buses per 1000 population			-2.232 (0.002)***

X_8	Cars per 1000 population			.255 (0.165)

Note: p-values in brackets; ***, ** and * indicate level of significance at 1 percent, 5 percent and 10 percent respectively.

The second regression is exclusively performed for number of persons killed in road accidents per 100,000 population. Model 1 as in table 5 suggests a causal relationship of explanatory variables like per capita expenditure on health by states and per capita income with fatalities in road crashes. The result of model 1 indicates that there is no significant impact of per capita health expenditure on fatalities in road crashes whereas per capital income is influencing the fatalities similar to the earlier case. Model 2 of in the table 5 presents results of fixed effect regression with cluster of variables incorporated in this analysis. These variables are per capita expenditure on health, per capita income, urbanization, population density and motorization as explanatory variables. Per capita expenditure in this model notably affects the deaths in road accidents and has negative impacts. Model 3 further incorporates trucks, buses and cars for panel data analysis. The result of this Model also suggests that increase in per capita expenditure on health services significantly affects the dependent variable. In addition to this, result also suggests that increase in buses decreases the number of deaths in road accidents considerably indicating the similar result as in case of table 4. It outlines that public transport is important for tackling accidents on roads.

Similar is the case of expenditure made on health care facilities. The expenditure is basically made for medical facilities in respective states. This expenditure does not provide any provision for post-accident health care facilities. Despite this fact, the increase in expenditure has major impact in reducing number of deaths in road crashes across Indian states. Increase in number of buses to strengthen public transport may also result in decrease in road crashes and also fatalities in road accidents. Urbanization on the other hand has positive impact on fatalities in road crashes. Our purpose was to establish a scientific relationship between road crashes fatalities and public health expenditure. With the available data on planned health expenditure, we are able to establish this relationship.

Table 5 Fixed effect regression results of panel data (dependent variable = accidental deaths/ 100,000 population)

Description of Variable	Independent	Model 1	Model 2	Model 3
X	Per capita planned expenditure on health services	-.001 (0.149)	-.001 (0.053)*	-.001 (0.043)**
X_1	Per capita income	.00006 (0.021)**	.00003 (0.245)	.00002 (0.336)
X_2	Urbanization (percent)		.276 (0.007)***	.343 (0.001)***
X_2	Population Density		-.001 (0.299)	-.001 (0.440)
X_4	Total Motorization per 1000 population		.010 (0.152)	-.002 (0.802)
X_5	Two-wheeler per 1000 population			.019 (0.317)
X_6	Trucks per 1000 population			.014 (0.939)
X_7	Buses per 1000 population			-.267 (0.014)**
X_8	Cars per 1000 population			.017 (0.470)

Note: p-values in brackets; ***, ** and * indicate level of significance at 1 percent, 5 percent and 10 percent respectively.

Fatalities in road crashes are higher in some states where incidents of accidents are relatively low. This happens due to the lack of proper medical facilities. The government has provision for planned expenditure on health and medical related facilities but this expenditure remains as low as 1.4 percent of GDP in 2013. After 2014, concept of planned expenditure was removed. These focuses are more or

less related to awareness among masses. Specific attention is needed for post-accident health care facilities and should be considered by the government. An initiative highlighted in box 1 is important for other states. It is important to identify stretches where accidents are frequently happening and provide urgent medical care.

8. Conclusion and Recommendations

The findings indicate that road crashes and fatalities are increasing on Indian roads. It presents a study of post-accident health care facilities. Among major states, Tamil Nadu, Maharashtra, MP, Karnataka, and Andhra Pradesh accounted for more than 52 percent of the total accidents in 2015. The fixed effect robust regression for number of accidents per 100,000 population as dependent variable shows that there is significant causal relationship in positive direction with per capita income. The result also suggests that there is a significant but negative relationship of dependent variable with increase in buses, population density, etc. The fixed effect robust regression of deaths per 100,000 population suggests that increase in per capita planned expenditure on health services has significant and negative effect on fatalities in road crashes. Thus, increase in public expenditure for post-accident health care will have positive impact on saving lives on Indian roads.

It is recommended that there is a need to make special arrangements for national highways which are passing through rural areas. Moreover, states which are backward need major attention. These states include, Bihar, Jharkhand, UP, Orissa and West Bengal. It requires specifically designed model for tackling problem of road crashes. This model should include indicators of state wise road crashes in rural as well as urban areas. Our analysis suggests that if road accidents increases in the states which are relatively economically backward then the number of fatalities will increase due to lack of proper medical facilities. Finally, there is no reason for undermining the severity of those states with lower deaths per 100 accidents and deaths per 100 persons injured in road crashes. These states include Tamil Nadu, Maharashtra, Karnataka, MP and AP having large share in road crashes.

State governments are less prepared for tackling road accidents. There is a need for coordinated efforts at both-- national and state levels. As part of SDGs, deaths due to road accidents have to be halved by 2020. As a target, this goal must be articulated in planning and policies not just by central government but also by the regional/state governments. In this context, the recommendations are as follows;

- Increase expenditure on post-accident health care facilities.
- Identify spots and zones where road crashes happen frequently in order to make plan for expenditure on health care facilities.
- While providing such facilities, national highways passing through rural areas need special attention.
- Increase expenditure on public transport which will potentially decrease road crashes.
- Special attention is required for those states which are economically backward and strengthen their public health and public transport services.

References

Augustus, O. A. (2012): "Determinants of Road Traffic Accident Occurrences in Lagos State: Some Lessons for Nigeria", *International Journal of Humanities and Social Science*, 2 (6), pp. 252-259

Andreassen, D. (1985): "Linking Deaths with Vehicles and Population."*Traffic Engineering & Control,* 26(11): pp.547-549.

Garg N. and Hyder A. A. (2006): "Exploring the Relationship between Development and Road Traffic Injuries: a case study from India", *European Journal of Public Health*, 16(5), pp.487–491

Kharola, P. S., Geetam Tiwari, and Dinesh Mohan (2010): "Traffic Safety and City Public Transport System: Case Study of Bengaluru, India", *Journal of Public Transportation,* 13(4), pp.63-91

Kopits, E. and Cropper, M. (2005): "Traffic Fatalities and Economic Growth",*Accident Analysis and Prevention*, 37 (1), pp.169-178.

MoRTH (2012, 2015, 2017): Road Accidents in India, Annual Report, Transport Research Wing, New Delhi

Mohan, D., and G. Tiwari (2000): Road safety in less motorized countries – Relevance of international vehicle and highway safety standards. *Proceedings of the International Conference on Vehicle Safety*, IMechE.

Mohan, D., O. Tsimhoni, M. Sivak, and M. J. Flannagan (2009): Road Safety In India: Challenges and Opportunities, http://deepblue.lib.umich.edu/bitstream/handle/2027.42/61504/102019.pdf

Michael Grimm and Carole Treibich (2012): "Determinants of road traffic crash fatalities across Indian States", working Paper Series no. 531, international Institute of Social Studies.

National Transport Development Policy Committee (2014): "India Transport Report: Moving India to 2032", Routledge, New Delhi

Smeed, R. J. (1949). "Some statistical aspects of road safety research". *Journal of the Royal Statistica l Society*,112 (1): pp. 1–34.

Tiwari, G., D. Mohan, and R. Muskaug (1998): Mumbai Urban Transport Project 2: Accident Study. New Delhi, TRIPP, Indian Institute of Technology Delhi. Final Report prepared for the World Bank.

VALLI, P. Pramada (2005): "Road Accident Models for Large Metropolitan Cities of India", *IATSS Research*, 29(1), pp. 57-65

Wilbur Smith Associates (2008): "Study on traffic and transportation policies and strategies in urban areas in India", Prepared for Ministry of Urban Development. Government of India.

World Health Organization. (2014). *Global status report on road safety 2015*. World Health Organization.

WHO (2014a), The top 10 causes of death, WHO Website, available at http://www.who.int/mediacentre/factsheets/fs310/en/

WHO (2016), Top 10 Causes of Death, https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death

World Health Organization. (2018). *Global status report on road safety 2018*. World Health Organization.