ROAD SAFETY GOOD PRACTICES IN INDIA

Contents

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Foreword

As a nation, India is growing exponentially, both economically and infrastructurally. While this growth brings opportunities, it also presents challenges, especially in ensuring the safety of our citizens on the roads. It is with great urgency and a sense of collective responsibility that I recommended that a report on Road Safety Good Practices that have shown positive results in India should be put together as a knowledge-sharing endeavour. This report by SaveLIFE Foundation, with support from the World Bank Group and the Ministry of Road Transport and Highways, aims to chart a safer course for India's roadways. This timely report focused on "Good Practices for Road Safety in India" marks an essential step in gathering, analysing, and disseminating information that can drive change and save lives. The insights contained within these pages spotlight interventions across various States, focusing on specific road corridors and geographies. The comprehensive analysis serves as a resource for policymakers, administrators, and stakeholders to identify and replicate strategies that have been effective in reducing road crash deaths.

Despite numerous laws and safety measures in place, India still bears a significant share of global road traffic deaths. The non-usage of seat belts and helmets, to name just two examples, has led to catastrophic loss of life. Thousands of families have been shattered, and the social and economic costs are staggering. As we are well aware, the magnitude of this issue necessitates a multipronged approach that involves the coordinated efforts of various government bodies, non-profit organizations, and the citizenry. Therefore, this report serves as a much-needed catalyst for fostering collaboration and encouraging the sharing of knowledge. It offers practical solutions, drawn from real-world examples, that can be tailored to suit the diverse conditions found throughout India. By honing in on successful interventions specific to certain corridors or localities, we provide a more nuanced understanding of what works—and what can work elsewhere if appropriately adapted.

Another strength of this report lies in its empirical approach. By rigorously documenting the impact of various safety interventions, it establishes a foundation upon which future efforts can be built. These metrics serve as a roadmap for scaling up successful initiatives, ensuring that they contribute to a broader, national strategy for reducing road fatalities and injuries.

In closing, I would like to extend my heartfelt gratitude to the SaveLIFE Foundation and the World Bank Group for their diligent efforts in creating this valuable report. As we continue our journey towards becoming a safer, more prosperous nation, let us keep in mind that every life saved is a step in the right direction, a vindication of our collective efforts, and a triumph for the country.

(Nitin Gadkari)

Acknowledgements

Abbreviations

ADAPT	Anticipatory Driving and Accident Prevention Training
ALS	Advanced Life Support
ANPR	Automated Number Plate Recognition
APTRSP	Andhra Pradesh & Telangana Road Sector Project
BCR	Benefit-Cost Ratio
BTLS	Basic Trauma Life Support
CCF	Crash Contributing Factors
CF	Challenge Fund
CHC	Community Health Center
CPR	Cardiopulmonary Resuscitation
CSR	Corporate Social Responsibility
CVA	Crash Vulnerability Audit
DBFOMT	Design-Build-Finance-Operate-Maintain-Transfer
DEESHA	Driving Electronic Enforcement to Save Human Lives
e-DAR	e-Detailed Accident Report
FIR	First Information Report
GDP	Gross Domestic Product
GIS	Geographic Information System
GSHP	Gujarat State Highway Project
HMV	Heavy Motor Vehicle
HSP	Highway State Police
ICF	Injury Contributing Factors
ICR	Implementation, Completion, and Results report
IEG	Independent Evaluation Group

IKT	Innuyir Kappum Thittom
iRAD	Integrated Road Accident Database
iRAP	International Road Assessment Program
IRC	Indian Roads Congress
IRSM	Indian Road Survey and Management
IndiaRAP	India Road Assessment Program
ITF	International Transport Forum
ITMS	Intelligent Traffic Management System
KMVD	Kerala Motor Vehicles Department
KHSDRP	Karnataka Health System Development and Reform Project
KMSCL	Kerala Medical Services Corporation Limited
KRSA	Kerala Road Safety Authority
KSHIP	Karnataka State Highways Improvement Project
KSTP-II	Second Kerala State Transport Project
LMV	Light Motor Vehicle
MACT	Motor Accident Claims Tribunal
MoRTH	Ministry of Road Transport and Highways
MPEW	Mumbai-Pune Expressway
MSRDC	Maharashtra State Road Development Corporation
NATPAC	National Transportation Planning and Research Center
NH	National Highway
NIMHANS	National Institute of Mental Health and Neurosciences
NK-48	Nammai Kaakkum 48
PAD	Project Appraisal Document
PHC	Primary Health Center
PPP	Public-Private Partnership
PWD	Public Works Department
R&B Department	Roads and Buildings Department

RSA	Road Safety Authority
RTO	Regional Transport Officers
SCCORS	Supreme Court Committee On Road Safety
SCDP	Safe Corridor Demonstration Project
SDG	Sustainable Development Goal
SDSL	Safe Drive Save Life
STF-RS	Special Task Force - Road Safety
TAEI	Tamil Nadu Accident and Emergency Care Initiative
TEAM	Traffic Education and Awareness Mobile
TEL	Tactile Edge Line
THQH	Taluk Headquarter Hospital
TNRADMS	Tamil Nadu Road Accident Database Management System
TRL	Transport Research Laboratory
TSG	Technical Support Group
UNSD	United Nations Statistics Division
VASS	Vehicle Activated Speed Sign
VKT	Vehicle Kilometers Traveled
VMS	Variable Messaging Sign
VRU	Vulnerable Road Users
WHO	World Health Organization
ZFC	Zero Fatality Corridor

Glossary of Terms

a. **Baseline survey/baseline assessment** is an analysis of the current situation to identify the starting points of a project. (European Commission 2023).

b. **Blackspot** is defined as a road section of 500 meter length or a jurisdiction that has road crashes higher than the average annual total crashes computed for the candidate road section/ network considered in the study (IRC 2022).

c. **Crash Vulnerability Audit** is an assessment conducted to identify and evaluate the vulnerabilities and risks associated with road crashes on a specific highway stretch or corridor. It aims to examine various factors contributing to crashes. (SaveLIFE Foundation, 2021).

d. **Decision-making Tools:** The World Bank defines "tools" as instruments, methodologies, or techniques used to support development work, including analytical tools, operational tools, financial tools, and knowledge and learning tools. These tools support the design, implementation, and evaluation of development policies, programs, and projects.

e. **Emergency Medical Care** comprises a dedicated set of services provided to those faced with urgent medical requirements. This set of services, spanning from the activities required when confronted with a medical emergency to specialized care by professionals, is necessary for creating an unbroken chain of survival, ensuring against loss of life and limb. (National Health Systems Resource Center 2010).

f.   Enabler: The World Bank's definition of an enabler refers to a policy, program, or intervention that creates a supportive environment for the desired impact. In the context of this study, the term enabler is used for any policy, program, or intervention that contributed towards facilitating a particular road safety project under observation.

g.   Forensic Crash Investigation is the process of scientifically analyzing the physical evidence and circumstances surrounding a road crash. It involves the collection and interpretation of evidence, including site investigation, examination of vehicles, crash reconstruction using specialized software, analysis of injuries, and detailed interviews. (SaveLIFE Foundation, 2019).

h.   Good Practices imply strategies, approaches, and/or activities that have been shown through research and evaluation to be effective, efficient, sustainable, and/or transferable and to reliably lead to a desired result. (European Commission 2021).

i.   Institutionalization is the process by which a set of activities becomes an integral and sustainable part of a formal system (Zida et al. 2017).

j.   Key learnings/ Lessons Learned are the knowledge gained during a project which shows how project events were addressed or should be addressed in the future with the purpose of improving future performance (Project Management Institute 2016).

k.   Network refers to a set of intersecting roads and their interconnections allowing the selection of several different travel paths between the start and end points (IGI Global 2019).

l. **Notification** in this report shall mean any Gazette notification, Government Order, Circular, or any other directive published by the Government of India or by any State Government/ Union Territory within the territorial jurisdiction of India.

m. **Police Enforcement** refers to supervising road users' compliance with traffic legislation, both by on-ground officials and technology designated to undertake this activity; their legal punitive rights to issue fines and detain offenders help prevent incidents of road traffic violations. (Department of Traffic Enforcement 2023).

n. **Replicable Practice** refers to a practice that can be scaled up or can be applied in a different setting. (The World Bank 2011).

o. **Road Engineering** refers to the process – based on an analysis of the road design and crash data of applying engineering principles to implement road design or traffic management improvements to reduce the number and severity of road crashes in a cost-effective manner. (Road Safety Engineering 2023).

p. **Road Safety Education and Awareness** refer to activities that educate road users with regard to proper and safe road usage to sensitize them to the importance of following traffic rules for a safer commute for themselves and other road users, and thereby influence behavioral change. (Road Safety Education and Training 2023).

q. **Vulnerable Road Users** are users defined as vulnerable with regard to their degree of protection in traffic, such as pedestrians, cyclists, non-motorized road users, and motorcyclists. (UNECE 2018).

Executive Summary

In 2021, India lost over 1,53,000 lives to more than 4,13,000 road crashes (MoRTH 2022). During the same period, over 3,85,000 persons were injured. On an average, India witnessed 1,130 road crashes and 422 deaths every day, translating to 47 crashes and 18 deaths every hour. Vulnerable road users such as pedestrians and motorized two-wheelers accounted for the majority of road crash deaths (64%); two-wheeler users comprised almost half of the total road crash deaths registered in 2021. Among high-fatality roads, highways emerged on top, with State and National highways, along with expressways, collectively witnessing 54.6% of all road crashes and almost 61% of all road crash fatalities, despite accounting for only 5% of the total road network.

It is important to note that a significant portion of fatalities on National and State highways in India is attributed to bad driving behavior, particularly speeding and negligent driving. To address this issue, strict enforcement measures are necessary. However, the current enforcement mechanism in India has been observed to be inadequate. Presently, enforcement is primarily carried out manually and is constrained by limited manpower and time frames within a day. This is especially evident on highways, where enforcement is usually conducted by the concerned State Police and Transport departments. Due to limited manpower, the level of enforcement on these highways remains low. Therefore, electronic enforcement systems are employed for continuous monitoring in some places, including on highways.

Roads in areas with high levels of mixed traffic very often do not have adequate infrastructure to accommodate pedestrians and non-motorized transport users. In addition, the inefficient use of

existing road infrastructure poses a huge challenge to road safety in India. This can be attributed to a lack of knowledge, education, and appropriate behavior among commuters. An illustrative example is the misuse of service roads: originally designed to accommodate local traffic needs, these service roads are often used as parking spaces or for other unauthorized activities by the local vendors, while the main carriageway intended for regular travel by local commuters ends up bearing the additional load. Consequently, this mix of local commuters with high-speed moving traffic increases the likelihood of crashes at such locations.

Various State Governments in India have devised ways and means to tackle the mammoth concern of reducing road crash deaths. Many of these "good practices" have shown results that make them exemplars for replication at other similar high-crash zones in India. The World Bank Group, in collaboration with SaveLIFE Foundation (an independent, non-governmental organization committed to improving road safety and emergency medical care across India and the developing world), has compiled this report to support these endeavors to reduce the overall road crash burden in the country, and make a leap towards achieving SDG 3.6. It compiles certain "good practices" implemented across States in India that have either been implemented in the past or are currently under implementation.

The good practices covered in the study were selected based on one or more of the following criteria:
a. Practices that resulted in a sustained reduction in road crash deaths during the project implementation period.
b. Practices that involved strengthening of institutions for efficient management of road safety interventions and effective inter-agency collaboration.
c. Robust mechanisms for ensuring road safety that have been implemented across the 4 E's that can be taken as intermediate indicators and provide evidence of progress towards key metrics- reduction in fatalities or crashes.

Most of the knowledge available on road safety in the developing countries that shoulder the majority burden of road crashes, fatalities, and injuries, is ad hoc and disjointed. This study aims to close this gap by putting forth a compilation of road safety good practices that can be utilized by various State government authorities for replication. The core objective is to document evidence-based good practices that have either reduced, or have shown promise in reducing deaths and injuries across different States in India. The path to achieving this reduction for each documented practice has been compiled in the guide.

To gather these practices, all the relevant stakeholder departments (i.e., police, transport, health, etc.) of all 28 States and 8 Union Territories across India were contacted through questionnaires. Further, global road safety literature was also reviewed to determine the scope and aspects that a good practice should capture. The available literature was also reviewed to understand the national road safety landscape, search for more promising road safety endeavors, and supplement the data shared by States. The responses from States, and the findings from secondary research have been compiled and presented in this report.

The practices and interventions studied in this report have been categorized as Corridor-based, City- and Network-based, and State-based interventions.

CORRIDOR-BASED INTERVENTIONS
The corridor-based approach captures interventions in various contexts - from a two-lane State highway in Karnataka to a six-lane expressway in Uttar Pradesh. Geographically, it captures interventions predominantly from Western and Southern India, barring the success of the Zero Fatality Corridor on the Yamuna Expressway. The States that have adopted a corridor-based approach include relatively high-capacity States such as Maharashtra, Gujarat, Tamil Nadu, Kerala, Karnataka, Andhra

Pradesh, and Telangana. The corridor-based practices focused heavily on engineering and enforcement initiatives. They also focused on enhancing emergency care systems on the particular corridor..

Chapter 3 of the report presents nine corridor-based interventions (two expressways, one National highway, and six State highways). Two major project types covered here are the Safe Corridor Demonstration Projects (SCDPs) and the Zero Fatality Corridor (ZFC) projects. The SCDPs of the World Bank in States such as Kerala and Karnataka led to a visible reduction in road crashes and deaths, due to multi-sectoral interventions in the areas of emergency medical care, road engineering, police enforcement, road safety education and awareness, and road safety management. These interventions can be replicated on high-fatality stretches across the country.

In terms of the specific interventions, installation of signages, crash barriers, pedestrian facilities, intersection improvements followed by active patrolling, and speed enforcement have been seen across corridors. To ensure widespread replication of the good engineering practices, efforts can be made to institutionalize them through the relevant IRC codes. Additionally, the practices can be called out specifically under Rule 166 of the Central Motor Vehicles Rules, 1989, which also provides statutory backing to the IRC codes as well as empowers the Government of India to issue guidelines from time to time for the design, construction and maintenance of roads. Strengthening of emergency response systems through measures such as the creation and upgradation of trauma care centers, and the optimal deployment of ambulances to reduce response time, have been undertaken across all corridor-based projects.

The tactics and approaches for safety on State highways have two key notable replicable practices. First, institutional measures created through legislation at the State level for monitoring all road safety-related work. For example, both in Kerala and Gujarat

- Road Safety Authorities were created to coordinate all road safety-related work amongst different stakeholders. Second, most of the practices on State highways focused on the upgradation of emergency care infrastructure and capacity building of staff. In certain cases, private capital through CSR was mobilized that helped unlock government funding for scale. The State highway corridor interventions covered in this report were jointly funded by the State Government and the World Bank.

In terms of safety outcomes, the Zero Fatality Corridor on NH-48 (Old Mumbai-Pune Highway) saw a 61% dip in deaths over three years (2018-2021), followed by SCDP in Karnataka on SH-20 (Belgaum-Yaragatti Highway) that saw 54% reduction in deaths in three years (2015-18). Some of the corridor-based practices such as the NH-48 and the Mumbai-Pune Expressway involved partnerships with the private sector. As private partners are increasingly becoming engaged in achieving the Sustainable Development Goals, such partnerships can help in improving road safety in the country. A report documenting such public-private partnerships in road safety can be the next step towards scaling them across India.

NETWORK-BASED INTERVENTIONS

Chapter 4 of the report presents two regional practices - one city-based and the other network-based. The city-based practice describes the success story of the interventions in Kolkata over five years (2016-2021), leading to a 52% dip in deaths. The Safe Drive, Save Life campaign led to Kolkata witnessing the biggest dip in road crash deaths amongst all Tier-1 cities (MoRTH 2022, Invest UP 2023). The interventions under the campaign focused on introducing electronic enforcement in the city and engineering interventions to address infrastructural concerns. It is also one of the few interventions that was evaluated by a third-party consultant - KPMG, which reported that the increased investment in road safety through the Road Safety Fund had a positive effect on bringing down the incidence of road crashes and deaths.

The Sabarimala Safe Zone is an example of a high impact project. It achieved a 100% reduction in road crash deaths in a 10-year time frame (2009-2019). The stretch had sustained this reduction and continued to see no deaths for the reported period, as per submissions by the Kerala Motor Vehicles Department. While the mortality burden in the Sabarimala Safe Zone was relatively low - 16 road deaths reported in 2009-10, the good practices to improve road safety can be replicated in other areas, especially religious tourist circuits such as the Uttarakhand Char Dham Yatra that witnesses a high number of road crash fatalities.

STATE-BASED INTERVENTIONS

Chapter 5 of the report presents two State-wide practices- one from Odisha, and the other from Tamil Nadu. Odisha saw a 4.1% reduction in deaths between 2018 and 2021, as per the submission from the Transport Department. The State has been lauded by the Supreme Court Committee on Road Safety (ET Infra 2022) for the implementation of various road safety measures, such as improved helmet compliance in Bhubaneswar, driver training programs, functioning of lead agencies and optimal utilization of road safety funds. Odisha also witnessed a 6.24% drop in fatalities in the second quarter of 2023, in comparison with 2022 (Odisha Post 2023). Tamil Nadu witnessed a 2.8% dip in road crash deaths from 2018 to 2022. This has been achieved by focusing on strengthening institutions, especially through the creation of a Special Task Force headed by ADGP SCRB, the creation of the Tamil Nadu Accident and Emergency Care Initiative (TAEI) headed by Principal Secretary Health and Family Welfare and the establishment of the Innuyir Kappom Thittam: Nammai Kakkum 48 scheme, which provides cashless treatment to road crash victims within the first 48 hours of the crash occurrence.

COMMON ELEMENTS

Emergency Medical Care is an important element across all projects documented in this report. In addition to the efforts of the States, the Government of India has created a universal emergency number-112 Emergency Response Support System (ERSS). Under this program, health, fire and police services will be integrated into one emergency number (Ministry of Home Affairs 2023). Numerous States have implemented the 112 emergency number in parts . For example, in Uttar Pradesh, the command center has a team of 150 members working in three shifts of eight hours each. The center handles around 2.5 million calls daily, distinguishing between Actionable and Non-Actionable Calls. The average closure time of all cases received by the Control Center is 28 minutes (ERSS Assessment Report 2023).

Another common element across all good practices is the optimal deployment of human resources to increase capacity at the grassroots and the administrative levels of road safety management in the State governments. For instance, the State TAEI Governance Committee in Tamil Nadu has numerous high-ranked stakeholders including the Principal Secretary, Health and Family Welfare Department. In parallel, it also involved capacity building at the grassroots level through training programs for medical professionals, nurses, and paramedics in handling trauma cases (Tamil Nadu Health and Family Department 2018). The success of each case study lies greatly in the smooth coordination of various stakeholders involved in each intervention.

RECOMMENDATIONS

An overall analysis of all thirteen case studies provides certain key practices that can be replicated across projects and contexts. Policymakers at the State and national levels can adopt a specific approach based on the context and the challenges they face. As mentioned above, the Sabarimala Safe Zone approach can easily be replicated by administrators in other religious circuit zones,

including the Uttarakhand Char Dham Zone, which sees a mass fatality crash almost every year. Similarly, practices followed in Karnataka can be replicated across stretches with mixed traffic and high pedestrian footfall. Stretches with a high density of VRUs and schools can follow the Kazhakuttom-Adoor Corridor model, wherein the school-focused safety interventions have helped reduce VRU deaths by around 50%.

For administrators looking for low-cost, temporary, and quick intersection or blackspot treatment, a Tactical Redesign trial at Karla Phata on NH-48 provides a good example. The ZFC model deployed on the Yamuna Expressway and the Mumbai-Pune Expressway is worthy of emulation on access-controlled highways. Forensic Crash Investigations and Crash Vulnerability Audits (followed by the Zero Fatality Corridor Model) can be used to determine the interventions that need to be prioritized in a corridor, zone, or a State. Similarly, a gap analysis of the existing emergency care infrastructure in the State (as was done in the case of Odisha) helps ensure that States can prioritize areas of improvement.

As Tamil Nadu and Odisha are high-capacity and low-capacity States respectively, these interventions can serve as models for replication across similar States in India. States that have low road safety funds can start by implementing corridor-based interventions on specific high-fatality corridors. Considering that 61% of the total road crash deaths occurred on National and State Highways (MoRTH 2022), by implementing a suitable corridor-based intervention, low-capacity States can also bring about a significant reduction in road crash deaths.

Two-wheeler users make up the maximum number of deaths every year, with over 69,000 deaths in 2021 (45% of total deaths) (MoRTH 2022). Yet, there was insufficient information on road safety interventions for two-wheeler safety. While Kolkata's "No Helmet No Petrol" campaign is an example of an intervention that briefly

induced behaviour change, it was not effectively implemented, and was eventually unsuccessful. Further, there are insufficient measures with respect to road engineering and enforcement for two-wheeler users. In countries such as Thailand, special enforcement projects for helmet detection using electronic enforcement were undertaken (The Phuket News 2016). Such projects can be replicated in India as well.

While most of these practices relied on assessment tools or enabling factors such as the presence of an authority, government orders, etc., their manifestation as successful projects, was possible only with the will and cooperation of State governments and local authorities. Given the rarity of sustained, broad-based, and multi-sectoral participation, road safety "good practices" require codification to make them scalable and replicable across India.

LIMITATIONS OF THIS REPORT

This report has the following limitations:

- The impact of each intervention has been measured for a stipulated period (until project closure), and cannot be used to extrapolate trends in previous or subsequent years. For example, the Hyderabad-Bijapur road under the SCDP, which was a project that was completed at the beginning of 2019, and had witnessed a drop of 38.1% in road crash deaths between 2014 and 2018, witnessed an increase in road crash deaths post the project completion and handover to a national road-owning agency, with 132 deaths registered between 2019 and 2020 (Hans India 2020).
- Some of the case studies do not include impact data due to its non-availability.
- An intervention-wise budget break-up is unavailable for some case studies, such as Gujarat, YEW and MPEW. Further, some aspects of the project's budget may have been excluded, as the data for case studies such as Karnataka's KSHIP-II has been collated through secondary information sources, which may be limited in their scope.

- The launch of digital crash data collection through iRAD/e-DAR nationwide was done to improve data collection and digitization on-ground (iRAD 2023). Due to the improvement in reporting mechanisms, the under-reporting of road crashes would be rectified. The improved reporting mechanisms may reflect increased road crashes and deaths in many States. However, this does not necessarily indicate that the road safety scenario on-ground has deteriorated. For example, Tamil Nadu saw only a marginal dip in road crash deaths because it has entirely digitized and implemented e-DAR to record road crash deaths. This may not be necessarily a reflection of the relative burden of road crashes in the State compared to other States.
- A validation exercise was also conducted to verify the stated impact of interventions in all the case studies. While positive outcomes were verified in most case studies showcasing reduced deaths and improved road safety, limited open documents were available for validation.
- The fatality reduction reported for various projects is based solely on reported data for target periods. No statistical before or after analysis has been undertaken for validation purposes.

CONCLUSION

India aims to meet the United Nations Sustainable Development Goal 3.6 to reduce road crash fatalities by 50% by 2030. Considering India's huge annual road death toll, the country needs to enhance the ongoing efforts to achieve a significant reduction in deaths as per the SDG 3.6. One way to do this is by documenting success stories and disseminating them widely for replication. This report is the first such initiative aimed at creating a dispassionate compendium of replicable good practices for State governments to tackle their road safety concerns. The study hopes that the case studies and recommendations it puts forth will allow for cross-functional knowledge exchange and sharing, collaborative actions, synergies, improved policies, practices and more informed initiatives by the State and city-level entities to improve their road safety outcomes.

Summary of Interventions

INSTITUTIONAL MECHANISM	ENGINEERING	ENFORCEMENT
Development of Plans: 1. Development of an Institutional Development and Strengthening Action Plan 2. Creation of a Dedicated Road Safety Fund 3. Notification of rules for a Non-Lapsable Road Safety Fund 4. Establishing a State-level Center of Excellence to disseminate sector-wise knowledge **Type of Private Sector Involvement:** 1. DBFOMT (Design- Build- Finance-Operate-Maintain- Transfer) 2. OPRC (Output and Performance-based Road Contracts) 3. Funding through CSR	**Road design:** 1. 2+1 Lanes for Safe Overtaking 2. Right Turn Protected Lanes 3. Delineators 4. Rumble Strips 5. Road Studs 6. Tactile Edge Lines (TEL) 7. Polychrome Convex Mirrors 8. Creation of Freight Parking Spots 9. No Parking Zones 10. Removal of Dangerous Roadside Objects 11. Street Lights for Night Time Visibility 12. Crash Barriers 13 Bus-stop Redesigns with Bays 14. Road safety considerations in the design and construction phase	**Monitoring:** 1. Training of officials on the Use of Monitoring Cameras 2. Deployment of Traffic Wardens at schools 3. Active Patrolling 4. Use of Interceptor Vehicles 5. Automatic Detection of Missing Permits, Missing Vehicles, and Violations 6. State-level Control Room 7. Use of Smart Patrolling vehicles 8. Intelligent Traffic Management Systems (ITMS) 9. Placing Highway Outposts
Strategies: 1. Creation of a Special Task Force on Road Safety to assess and prevent road crashes 2. Collaboration with Local Experts known as Faculty Partners 3. Survey of Enforcement Measures 4. Surveys for analyzing the Causes of Road Crashes 5. Deployment of Quantifiable Measures for Impact	**Road Signages and Markings:** 1. Upgrading and placing Road Signages wherever required 2. Road Markings a. Yellow Painted Stripes b. Yellow and White Ladder Lines c. White "SLOW" and "SCHOOL ZONE" Markings d. Zig-Zag Lines e. Box Markings f. Edge Lines g. 3D Pavements h. Colored Pavements i. Chevron Markers j. Retro-Reflective Markers k. Three-set Deflector Arrows	**Devices:** 1. Breathalyzers (with printer) 2. Speed Guns (laser and radar) 3. Speed Traps (fixed and actively relocatable) 4. Automated Number Plate Recognition (ANPR) 5. Vehicle-Activated Signs (VASs) 6. Red Light Violation Detectors 7. Electronic Weigh-in Bridge 8. Variable Message Signs (VMS) 9. Digital Camera 10. Accessible Push Buttons for Pedestrian Crossing 11. Reflective Jackets
Data-driven interventions 1. Road Safety Audits for repeated blackspots (including manual and third-party audits) 2. Forensic Crash Investigation for Root Cause Analysis Matrix 3. Risk Assessment using automated iRAP techniques 4. Crash Vulnerability Audits (CVAs)	**Intersection redesign:** 1. Tactical Redesign 2. Creation of Refuge Islands 3. Installation of Blinkers in Median Gaps 4. Creation of Splitter Islands 5. Construction of Raised (table-top) Crossings 6. Incorporating Traffic Channelization and Speed Calming Measures 7. Installation of Retroreflective Pavement Markings 8. Grade-separated Pedestrian Crossings	**Risk Factor Management:** 1. Dynamic Speed limits 2. Training Officials on Speed Management Techniques 3. Police Counseling to non-users of helmets and seat belts 4. Strict Rear Seat Belt enforcement on highways 5. E-Challan System
Database Management: 1. IT-based Trauma Registry 2. Road Accident Database Management System (iRAD/e-DAR 2023) 3. Accident and Enforcement Data Collection		

EDUCATION/ ENGAGEMENT	EMERGENCY MEDICAL CARE
Trainings: 1. Post Crash Care and Road Safety (especially for adjacent communities) 2. First Aid Delivery 3. Forensic Crash Investigation (for police personnel) 4. Training in Basic Crash Prevention Techniques (for Truck drivers) 5. Anticipatory Driving and Accident Prevention Training (ADAPT) for Drivers 6. Refresher training through Workshops whenever required 7. Special Training in Blackspot Regions for school children, bus drivers, conductors, auto drivers/two-wheeler drivers/stage carriage drivers 8. Upgradation of Driver Training Institutes 9. Training of Contractors, Road Engineers, Concessionaires, and Consultants	**Trainings:** 1. First Aid Delivery (especially for adjacent communities) 2. Training for Doctors in District hospitals, PHCs, and Taluk Hospitals 3. Training for medical personnel at Identified Emergency Medical Facilities 4. Airway, Breathing, Circulation, Disability, and Exposure (ABCDE) Training for Healthcare Professionals 5. Basic Trauma Life Support (BTLS) for police professionals 6. First Responders Training program
Awareness Methods: 1. Media Brochures 2. Short Films 3. Public Announcements 4. Street Plays 5. Mandatory Short Films at Movie Theatres 6. Public Meetings 7. Pamphlets and Leaflets 8. Radio Campaigns 9. Multilingual Audio Messages at Toll Plaza	**Emergency Medical Facilities:** 1. Mapping all Emergency Medical Facilities 2. Identification of Trauma Facility Gaps 3. Identification of Existing Medical Colleges and Hospitals for training in trauma care 4. Establishing new facilities or Trauma Care Centers (TCC) 5. Upgrading existing facilities (TCC) 6. Designating a hospital in each District as TCC
Other Interventions: 1. Road Safety Hackathon 2. "No Helmet, No Petrol" rule 3. Awareness Programs at Schools for Children and their Guardians 4. Inclusion of Road Safety chapters in the curriculum 5. Road Safety Fairs 6. Road Safety Short Film Festival 7. Traffic Education and Awareness Mobile (TEAM) Vans	**Ambulance Service:** 1. Ensuring all Ambulances are equipped with State-of-the-Art-Equipment 2. Deployment and stationing of Ambulances near High-Fatality Zones 3. Reduction in Ambulance Response Time by utilization of ambulance deployment tools
	Other Key Interventions: 1. Detailed Action plan for Health Departments 2. Cashless Treatment of road crash victims 3. Safe Zone Helpline 4. Regular Eye testing and general health checkups for Truck Drivers 5. Strengthening Emergency Care systems - e.g., Tamil Nadu Accident and Emergency Initiative

Corridor-Based Initiatives

BELGAUM- YARAGATTI HIGHWAY STRETCH, KARNATAKA — 7 YEARS (2011-2018)

62 km- 2 lane stretch

Impact
2015 - 2018
54% reduction in
road crash deaths

Decision Tool
Analysis by iRAP,
Asian Development
Bank and VicRoads

Enabler
Work Order by
State Public Works
Department (PWD)

Project Road Safety Funding
Total Road Safety
Funding:
INR 628.9 million
(USD 9.2 million)

KAZHAKOOTTAM- ADOOR CORRIDOR, KERALA — 8 YEARS (2013-2021)

80 km stretch

Impact
2013-2021
46% reduction
in total road crash
deaths

Decision Tool
iRAP Study

Enabler
Work Agreement
awarded under
Safe Corridor
Development Project

Project Road Safety Funding
Total Road Safety
Funding: INR 1.79 billion
(USD 22.9 million)

OLD MUMBAI- PUNE HIGHWAY, NH-48, MAHARASHTRA — 2018- ONGOING

111 km Stretch on NH 48

Impact
2018 - 2021
61% reduction in
road crash deaths

Decision Tool
Road Safety Audits,
FIR Data, Crash
records from Injury
Reports

Enabler
MOU between
MSRDC and an NGO
working on road
safety

Project Road Safety Funding
Jointly funded by
MSRDC and CSR funds.
Total Road Safety
Funding: Not Available

Corridor-Based Initiatives

YASHWANTRAO CHAVAN EXPRESSWAY, MAHARASHTRA   2016- ONGOING

94.5km six-lane wide, access-controlled Expressway

Impact
2016 - 2022
40% reduction
in deaths

Decision Tool
Audits, forensic
crash investigation,
electronic
enforcement tools

Enabler
MOU between
MSRDC and an NGO
working on road
safety

**Project Road Safety
Funding**
Jointly funded by
MSRDC and CSR Total
Road Safety Funding
were INR 2-2.5 billion
(USD 24.3-30.4 million)
over a period of 7 years

RENIGUNTA- KADAPA STRETCH, ANDHRA PRADESH   5 YEARS (2014-2019)

138 km stretch

Impact
2012 - 2015
22% reduction in
deaths between

Decision Tool
iRAP Report on Road
Quality

Enabler
Government order,
Roads and Buildings
Department, Andhra
Pradesh

**Project Road Safety
Funding**
AP Govt. - INR 349
million (USD 5 Mill.);
World Bank - USD 12
Million (INR 834 million)
for Road Safety:
USD 9.6 Million (INR 668
million) for Institutional
strengthening

HYDERABAD- BIJAPUR CORRIDOR, TELANGANA   4 YEARS (2015-2019)

118 km Stretch

Impact
2014-2018
38.1% reduction
in road crash deaths

Decision Tool
FIR Data

Enabler
Government order,
Roads and Buildings
Department,
Telangana

**Project Road Safety
Funding**
Total Road Safety
Funding: USD 4.3 Million
(INR 297.9 million)
jointly funded- Govt. of
Telangana and World
Bank

Corridor-Based Initiatives

YAMUNA EXPRESSWAY, UTTAR PRADESH — 2020- ONGOING

165.5 km

Impact
2019 - 2022
37.7% reduction
in road crash deaths

Decision Tool
Forensic Crash
investigation, Crash
Data Analysis

Enabler
MOU between
Government of
Uttar Pradesh and
an NGO working on
road safety

**Project Road Safety
Funding**
Total Road Safety
Funding not available

BHARUCH- DEHGAM CORRIDOR, GUJARAT — 7 YEARS (2014-2021)

11.3 km

Impact
-

Decision Tool
-

Enabler
-

Project Road Safety Funding
Road safety component - USD 13 million (INR 952 million)
out of which 83.8% were World Bank funds and 16.2%
were funded by Government of Gujarat

GANDHINAGAR- KOBA- INDIRA BRIDGE, GUJARAT — 3 YEARS (2018-2021)

11.5 km

Impact
-

Decision Tool
-

Enabler
-

Project Road Safety Funding
Road safety component - USD 13 million (INR 952 million)
out of which 83.8% were World Bank funds and 16.2%
were funded by Government of Gujarat

Corridor-Based Initiatives

MEHSANA- HIMATNAGAR HIGHWAY, GUJARAT   1 YEAR (2017-2018)

66 km

Impact	Decision Tool	Enabler	**Project Road Safety Funding**
-	-	-	Road safety component - USD 13 million (INR 952 million) out of which 83.8% were World Bank funds and 16.2% were funded by Government of Gujarat

UTHIRAMERUR- KANNAMANGALAM CORRIDOR, TAMIL NADU   6 YEARS (2015-2021)

4 road stretches-95.6 km

Impact	Decision Tool	Enabler	Project Road Safety Funding
-	-	Tamil Nadu State Highway Department and World Bank	-

City and Network-Based Initiatives

SAFE DRIVE, SAVE LIFE CAMPAIGN, KOLKATA   2016- ONGOING

City of Kolkata

Impact
2016 - 2021
51.8% reduction
in road crash deaths

Decision Tool
Crash Data from
Police Departments

Enabler
Directions by the
Chief Minister of
West Bengal

**Project Road Safety
Funding**
-

SABARIMALA SAFE ZONE PROJECT, KERALA   2009- ONGOING

400 km stretch around the Sabarimala Temple

Impact
2009-2021
100% reduction in road
crash deaths and a 91%
reduction in road crash
injuries

Decision Tool
Data from State
Crime Records
Bureau

Enabler
Kerala Road Safety
Authority Act (2007)

**Project Road Safety
Funding**
INR 28.2 million
(USD 343,065) for 400 km
for a duration of 3 years

State-wide Initiatives

STATE GOVERNMENT ROAD SAFETY INITIATIVES, ODISHA   2019- ONGOING

Impact
2018-2021
4.4% reduction in road crash deaths

Decision Tool
Data from State Crime Records Bureau

Enabler
Directions from meetings of Road Safety Fund Management Committee; Government orders for implementation of Engineering and Enforcement measures

Project Road Safety Funding
INR 318.7 million (USD 3.9 Million)

STATE GOVERNMENT ROAD SAFETY INITIATIVES, TAMIL NADU   2017- ONGOING

Impact
2018 and 2022
Current reduction in road crash deaths by **2.8%**

Decision Tool
iRAD/ e-DAR (data analysis tool)
FIR data from Police Departments

Enabler
Government orders for the implementation of the Tamil Nadu Accident and Emergency Care Initiative and constitution of the Special Task Force

Project Road Safety Funding
TAEI - initial cost INR 570 million (USD 6.9 million)
Innuyir Kappom Nammai Kakkum 48 Scheme -INR 1.4 billion (USD 17.4 Million) until 2023
TNRADMS - INR 22 million (USD 267,640)

Chapter I:

Introduction

Annually, road crashes lead to approximately 1.35 million deaths globally (World Health Organization 2018). Of these, over 90% are witnessed in low- and middle-income countries (World Health Organization 2018). An even-larger number of people comprise those injured and permanently disabled in these road crashes. India has the dubious distinction of being the country with the highest number of road crashes, deaths, and injuries in the world (Jha 2022). In 2021 alone, India lost over 153,000 lives to road crashes (MoRTH 2022). The economic burden of these road crashes has been estimated at a 5-7% loss to the Indian GDP (World Bank 2022). With a severity index of 38 (MoRTH 2022), nearly every 4 in 10 road crashes in India result in deaths. These alarming numbers indicate the urgency of addressing our country's road crash epidemic.

India is committed to actions geared towards making its roads safer for all types of road users. As a signatory to the 2020 Stockholm Declaration, India is committed to achieving Sustainable Development Goal Target 3.6 (SDG Target 3.6 2023) to reduce road crashes and deaths by 50% by 2030 (Rajya Sabha 2022). The pursuit of road safety is also an essential part of the holistic fulfillment of two of the primary World Bank goals, namely, the eradication of extreme poverty and the increased shared prosperity, as well as SDG 11, which strives to make cities inclusive, safe, resilient and sustainable and within it, Target 11.2 which aims to provide affordable and sustainable transport systems (SDG 11: Sustainable Cities and Communities).

For a nation tasked with reducing road crashes and deaths by 50% in less than a decade, these "good practices" can serve as an indispensable resource. This handbook aims to capture such projects to provide actionable information and insights for relevant parties to aid their replication. In the following pages, the "how" and "why" of good practice have been given as much priority as the "what."

1.1 WHY THIS REPORT?

The road crashes confronting India are an epidemic in the true sense of the word and require the active and continuous collaboration of multiple stakeholders to combat them. Institutions ranging from the Central Government, State, and local governments, traffic enforcement officials, and the overall medical fraternity in general, and the emergency care services, in particular, have an essential role in ensuring a steady decline in road crashes and subsequent injuries and deaths. With the active involvement of so many diverse institutions, it is necessary to ensure that all relevant knowledge, information, and strategies are made available to the most significant number of stakeholders who may use the same to help work towards the goal of reducing road crashes. Scientifically accurate and reliable information demonstrating what has been done and how it can be replicated for safer roads is a necessary tool for helping address the road crash concern confronting India and similar low- and middle-income countries worldwide.

1.2 COMPOSITION OF THE REPORT:

This report attempts to collate from across India examples of road crash concerns and their proven remedies across the domain of road engineering, traffic enforcement, public engagement and emergency medical care. The report lists "Good Practices," defined by the World Health Organization (WHO) as "a technique or methodology that, through experience and research, has

proven reliably to lead to a desired result" (WHO 2017). The report lists and describes "good practices" that have either brought about a reduction in road crash deaths, or have led to strengthened road safety institutions. The practices were divided based on the type of geographical location in which the interventions were implemented. They were divided into three categories: corridor-based practices, State-based practices, and city and network-based practices. Each of the road safety initiatives studied in this report was deployed across India by various stakeholders across States. Other State governments can replicate them to reduce road crashes and deaths in their jurisdictions. The study concludes with a list of recommendations for replicating such "good practices."

1.3 FOR WHOM?

This functional and innovative repository of road safety solutions aims to detail the nuances of these good practices or solutions and the components required to replicate them within a similar context. The report is meant to be utilized as a blueprint for stakeholders across States in India to implement the interventions most suitable for their respective jurisdictions and, as a result, improve road safety on-ground.

1.4 WHAT TYPE OF MEASURES ARE INCLUDED?

The document describes road safety practices in the following areas:
• Framework and management for efficient road safety
• Road infrastructure safety
• Enforcement of traffic law
• Behavior of road users and campaigns
• Post-crash care
• Data collection and analysis

1.5 WHERE TO FIND WHAT INFORMATION?

The report includes corridor-based road safety good practices from Karnataka, Kerala, Maharashtra, Andhra Pradesh, Tamil Nadu, Telangana, Uttar Pradesh, and Gujarat. The tier-1 city Kolkata and Kerala's road network in the Sabarimala Safe Zone are examples of city- and network-based good practices that have been presented in this study. This report also includes State-based good practices for Odisha and Tamil Nadu, a low- and high-income State respectively, to help put forth learnings and guidance for States that may identify themselves with either and put in place the replicable "good practices" seem to have performed positively for both these case studies. Each good practice includes details on the interventions spread across the 4 E's of road safety- Engineering, Enforcement, Emergency Care, and Education/Awareness. The good practices also include institutional mechanisms that enabled smooth road safety management and all other aspects which made the "good practices" possible and sustainable. Chapters 3-5 present the good practices in detail, capturing all information relevant for replication both in sections as well as in totality. Finally, chapter 6 provides the recommendations across the 4 E's that can be scaled up nationally. This report, with the help of data and evidence, puts forth initiatives detailed in a granular manner that may be adopted by States that are confronted with road safety concerns. These initiatives can either be used in totality or may inspire action on the part of States which are free to cull out the exact knowledge necessary to help their unique context and specific priorities requiring immediate attention and action.

Chapter II:
Research Methodology

AIMS, OBJECTIVE, AND METHODOLOGY:

Even though low- and middle-income countries witness more than 90% of the 1.35 million deaths globally, most road safety-related good practices have been emerging, primarily from developed countries. Although evidence-based, these good practices sometimes overlook regional realities and challenges. Success models from developed countries have specifically informed the blueprint to achieve Goals 3.6 and 11.2.

Relevant knowledge is essential to formulate State and national road safety strategies. The affected populations and concerned government bodies need reliable information to study and improve the efficacy and efficiency of systems. Uncodified road safety knowledge hampers relevant parties' ability to use them. This guide aims to document and codify the best available experiences regarding road safety strategies.

The core objective of this study is to document evidence-based good practices that have either led to measurable reductions in deaths and injuries or have shown promise in bringing about a reduction in road crash deaths in the future, through strengthening of institutions across different States in India. By doing so, it attempts to serve as a handbook for States to replicate the practices cited within.

As action-oriented research, this handbook's methodology predominantly focuses on information gathered through primary and secondary sources through a qualitative approach. The measures documented in this report were collected through the following process:

1. Pre-evaluation exercise: A pre-evaluation exercise involving desk research and formal in-depth interviews with experts at AIIMS Rishikesh, IIT Kharagpur, the World Bank, NIMHANS, and the Supreme Court Committee on Road Safety were conducted to take their insights on promising practices implemented across the country. The desk research involved a review of material available on various government portals, including websites of the Ministry of Road Transport and Highways, National Crime Records Bureau, State Transport Department websites, documents/publications of accident research cell at the State/UT level and Road Safety Action Plan, media reports about the road safety measures undertaken at the State/ UT level.

2. Preparation and Dissemination of the Good Practices Questionnaire: A questionnaire to survey the relevant stakeholders, was prepared in agreement with the World Bank to capture the good practices across road engineering, traffic enforcement, emergency medical care, road user education, and engagement, collection of evidence, and enactment of appropriate policies. The questionnaire was informed by the perspectives shared in the in-depth interviews.

3. Target Respondents: The questionnaire regarding a particular State was addressed to either the Principal Secretary, Transport, or the Transport Commissioner. The State questionnaire probed on not just district-level initiatives but also initiatives that happened on specific stretches/corridors, to name a few.

4. Collection and Collation of Data: Questionnaires were emailed to 28 States and 8 UTs. States were reached telephonically to confirm receipt of emails, understand the response status, and follow up on the submitted good practices. Further, RTI (Right to Information) requests were also filed to receive additional road crash data for stretches wherein good practices have been implemented. Out of 28 States and 8 UTs, 10 States shared

the data and information on the good practices undertaken to reduce road crash deaths by submitting the questionnaire or through various internal documents. Out of this, information from seven States: Odisha, Kerala, Maharashtra, Uttar Pradesh, Telangana, Tamil Nadu, and Gujarat, was selected to be profiled in the guidebook.

Additionally, secondary research sources provided information on road safety practices from Karnataka, Kolkata, and Andhra Pradesh. The report has information on nine corridor-based interventions, two State-based interventions, and two city and network-based interventions.

CLASSIFICATION OF GOOD PRACTICES BASED ON THE TYPE OF GEOGRAPHICAL AREA	
Corridor-based interventions	Belgaum-Yaragatti Highway (SH-20), Karnataka
	Kazhakoottam-Adoor Corridor (SH-1), Kerala
	Old Mumbai-Pune Highway (NH-48), Maharashtra
	Mumbai-Pune Expressway, Maharashtra
	Renigunta-Kadapa Stretch (SH-31), Andhra Pradesh
	Hyderabad- Bijapur Corridor, Telangana
	Yamuna Expressway, Uttar Pradesh
	Bharuch-Dehgam Corridor, Gandhinagar-Koba-Indira Bridge, Mehsana- Himatnagar Highway, Gujarat
	Uthiramerur - Kannamangalam Corridor, Tamil Nadu
City and Network-based interventions	Kolkata
	Sabarimala Safe Zone Project, Kerala
State-wide practices	Odisha
	Tamil Nadu

Chapter III:
Corridor-Based Practices

The efficacy of improving safety in high-fatality zones relies on a multitude of factors and the specific contextual circumstances. Decisions regarding interventions, whether they pertain to a city, corridor, or zone, are contingent upon the nature and extent of the existing road safety issues and the corresponding strategies required to address them. The subsequent section explores case studies where corridor-based practices were implemented, outlining the rationale behind their adoption and the methodologies employed in their execution.

Implementation of corridor-based interventions is suitable when data and research indicate corridor-specific road crash death numbers to be significantly higher than the State or national average. For example, in 2014, the Hyderabad-Bijapur corridor witnessed a crash severity (i.e. deaths per 100 crashes) of 58.7. During the same year, the national crash severity stood at 28.5. The reasons for such massive crash severity could range from high traffic volumes to inadequate infrastructure, engineering issues, limited visibility, a combination of these, and multiple other factors.

Two major project types covered in this chapter are the Safe Corridor Demonstration Projects (SCDPs) and the Zero Fatality Corridor (ZFC) projects. The flagship Safe Corridor Demonstration Projects (SCDPs) of the World Bank in States such as Kerala and Karnataka led to a visible reduction in road crashes and deaths, courtesy of multi-sectoral interventions in the areas of emergency medical care, road engineering, police enforcement, road safety education and awareness, and road safety management. These interventions can be replicated on high-fatality stretches across the country. "The Safe Corridor Demonstration Program has been

established through a joint World Bank and Government of India agreement in order to help support various State Governments in the development, implementation and evaluation of major multi-sector road safety schemes. This enabling initiative seeks to build capacity within the Government to deliver numerous lead agency functions for future major projects throughout the State." (iRAP 2012)

Zero Fatality Corridor model is a nuanced and innovative approach aimed at making high-fatality stretches safer. It is currently deployed across a few of the most dangerous State and National highways and expressways across 16 States in India. Interventions undertaken within the ambit of this model include thorough scientific analysis of high-fatality stretches and the crashes witnessed there to propose tailor-made solutions aimed at addressing them. This 360-degree approach has yielded an over 61% reduction in road crash fatalities on the Old Mumbai-Pune Highway (NH-48). On the Mumbai-Pune Expressway, the model has delivered a 40% decline in road crash fatalities between 2016 and 2022 and a 38% decline on the Yamuna Expressway between 2019 and 2022.

The strategic implementation of corridor-focused projects offers remarkable advantages, particularly when State governments identify specific corridors with consistently poor road safety records. This allows for targeted interventions on the specific stretch across the four Es of road safety, namely, Engineering, Enforcement, Emergency Care, and Engagement, to make them safer. Such focused attention and action where the maximum need has been detected is significantly better than working throughout the State and diluting funds, attention, and personnel hours. Also, the smaller scale of a stretch vis-a-vis a State makes it easier to plan, seek and receive relevant permissions and execute in tandem with other stakeholders involved. For road-owning agencies and enforcement officials, and government authorities, collaborating on a high-fatality stretch involves the scope for more significant and easier collaboration, adequate supervision, and more robust implementation.

For road-owning agencies, enforcement officials, and government authorities, joining forces on such a focused project enables more significant collaboration opportunities, streamlined supervision, and robust implementation. By harnessing this approach, administrators can pave the way for transformative change and a safer road environment for all.

State-wide projects typically require the involvement and coordination of multiple departments, agencies, and stakeholders. They are usually driven and overseen by higher-ranking officials, policymakers, or governing bodies with the necessary influence and resources to ensure effective implementation. In comparison, stretch-specific, comparatively smaller-scale initiatives allow for greater involvement, oversight, and leadership from junior officials. These grassroots initiatives that are easier to plan, coordinate and execute are much more effective in providing targeted action to reduce road crashes, injuries, and deaths.

The decision of which aspects of the 4Es of road safety to focus on depends firstly on the areas that require immediate and greater attention and, secondly, the availability of necessary resources and facilities on or close to the stretch. For instance, if the authorities possess strong enforcement capacity, efforts towards enforcement-centric intervention can be focused on. At the stretches where high mass-fatality crashes and lack of emergency medical services and response timings have been detected, the focus should ideally be on shorter response times and greater immediate emergency medical response. Engineering interventions should be implemented on stretches where road engineering issues emerge as the primary cause of road crashes, injuries, and deaths, through audits and investigations. Engagement and road safety awareness activities should be undertaken near all high-fatality stretches to sensitize regular users and those living in the vicinity concerning both the correct usage of the stretch as well as ways and means of acting as a Good Samaritan in the event of a crash and providing the necessary, timely assistance.

Case Study 1:
KARNATAKA

Belgaum-Yaragatti Highway (SH-20)
Safe Corridor Demonstration Project (SCDP)

The 62 km Belgaum-Yaragatti Highway saw 179 crashes and 50 deaths in 2015. Interventions across the 4E's were implemented on the stretch, which resulted in a 54% reduction in deaths from 2015 - 2018. The Karnataka Public Works Department (PWD) was the primary implementing agency.

1 KEY DATES: THE PROJECT WAS APPROVED ON MARCH 24, 2011, IMPLEMENTED ON JULY 17, 2011, AND COMPLETED ON DECEMBER 28, 2018

3 IMPACT: REDUCTION IN ROAD CRASHES: 53% BETWEEN 2015 AND 2018. REDUCTION IN ROAD CRASH DEATHS: 54% BETWEEN 2015 AND 2018

2 AREA COVERED: 62 KM, 2-LANE STRETCH ON SH-20 FROM BELGAUM TO YARAGATTI (PLAIN LAND WITH A HILL ROAD SECTION)

4 SCOPE OF REPLICATION: THE INTERVENTIONS ON THIS STRETCH CAN BE REPLICATED IN HIGH-FATALITY STATE HIGHWAY CORRIDORS WITH VARIED TOPOGRAPHY (E.G., A MIX OF PLAIN AND HILL STRETCHES) AND HIGH PEDESTRIAN FOOTFALL

Road Crash and Road Crash Death: Belgaum- Yaragatti Highway
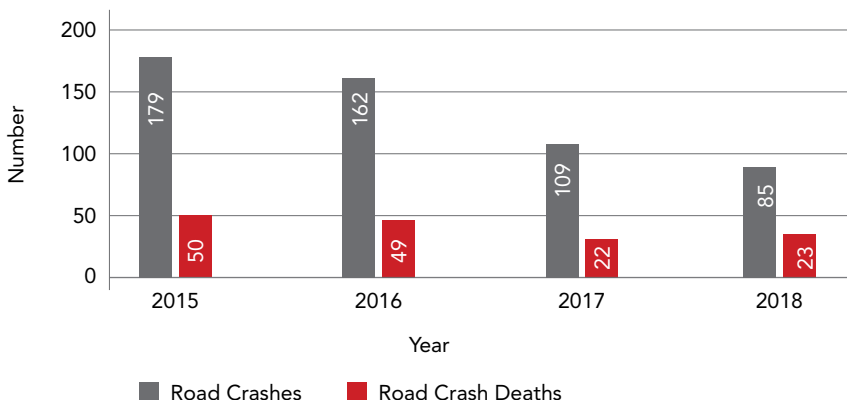
Graph 1.1: Road crashes and deaths between 2015 and 2018 on the SH- 20

1.1 ABOUT THE PROJECT

The 62-km-long, two-lane Belgaum-Yaragatti stretch is a part of the larger Belgaum-Bagalkot Highway (SH-20) (IndiaRAP 2019) and runs through the districts of Bailanhongal, Belgaum and Saundatti in Karnataka. The stretch was selected for a Safe Corridor Demonstration Project under the Second Karnataka State Highways Improvement Project (KSHIP-II) (Government of Karnataka 2014). This project saw collaboration between the PWD, Home, Health, Education, and Transport departments (Government of Karnataka 2014).

1. Documents / Information reviewed:
a. iRAP Baseline Data Collection in India-Karnataka Phase, 2012
b. Post Construction iRAP Assessment, India, Belgaum – Yaragatti SH-20, Karnataka 2019
c. World Bank Implementation Completion Report (ICR) 2019
d. World Bank Blogs, 2019
e. IEG Review Team Report, 2019
f. Paper titled "Making Safe Corridor by Engineering Interventions and Enforcement Interventions in Karnataka (India)"
g. IDI with Dr. G. Gururaj, NIMHANS Bengaluru, 2023

2. For the purpose of this case study, the exchange rate effective is $1=Rs. 68.36 as on July 11, 2019, as mentioned in the World Bank ICR Report 2019

1.2 BACKGROUND

In 2011, the International Road Assessment Program (iRAP) selected Karnataka's Belgaum-Hungund stretch for an assessment under its road assessment program. Following this, Vic Roads Consultants, an Australian governmental body from the State of Victoria, submitted its report in August 2012, suggesting the selection of the smaller Belgaum-Yaragatti stretch (i.e. 62 km), which was found to be representative of the road safety challenges identified in the larger stretch assessed earlier by iRAP. In the report, Vic Roads also suggested the engineering interventions that would deliver the maximum benefit regarding road safety on the selected corridor (Government of Karnataka 2014).

Following this finding, the State Public Works Department (PWD) implemented a Safe Corridor Demonstration Project on the Belgaum-Yaragatti two-lane stretch under the second Karnataka State Highways Improvement Project (KSHIP-II). In 2014, a Black Spot Investigation was also conducted by VicRoads wherein 23 high-risk black spots were identified in the Belgaum district (Deccan Herald 2014).

Decision-Making Tools:
- Analysis by iRAP, Asian Development Bank and VicRoads

Enabler:
Work orders by the State Public Works Department (PWD)

Validation Mechanism:
- A pre-construction Baseline assessment was conducted by iRAP with the help of the Asian Development Bank, followed by a Post Construction-assessment in April 2019.

1.3 INTERVENTIONS

1.3.1 Institutional Strengthening:

1. **Institutional Development and Strengthening Action Plan:** A detailed plan of action was developed to strengthen the road safety institutions in the State. This was called the Institutional Development and Strengthening Action Plan (IDSAP). The project included the implementation of a medium-term IDSAP from 2010-2016. The plan was based on four key areas:

a. To check the effectiveness of the business processes such as the ISO certification for Quality Management, management of the environment, and online project management systems, to name a few.

b. To check the sustainability of the assets, which entailed components such as the functioning of the planning and road asset management center, and setting up the Karnataka Road Asset Management System (KRAMS).

c. To check the performance and accountability, such as the functioning of a 24x7 public resource center.

d. Management of human resources entailed training plans and e-learning management systems, to name a few. (World Bank ICR 2019)

2. **Road Safety Budget Allocation:** In the Financial Year 2017-18, the Government of Karnataka established a dedicated road safety budget just for the road safety program under KSHIP. Under the directions of the SCCoRS NO.16/CoRS/2016 dated 24th November 2016, all States were required to make a dedicated road safety budget. What stood out in Karnataka was the method for budget allocations, which were made through informed decisions backed by data from the KRAMS. This led to efficient budget allocation (World Bank ICR 2019). The project also involved the establishment of a road safety cell, which was responsible for preparing budget proposals based on the data collected by police and field officials (ITF 2022).

Figure 1.1: Improved intersection and pedestrian facility at the corridor
(Source: IndiaRAP 2019)

3. **Deployment of Quantifiable Measures to Identify Road Safety Interventions:** The iRAP assessment in 2011 involved quantifiable parameters for each road safety intervention that could be deployed on the stretch. For efficient deployment of resources and investments in road safety, iRAP used the following three estimates to test road safety interventions' effectiveness:

a. Star ratings and traffic volume data for the stretch. iRAP developed a globally accepted measure called "star ratings" to rate the safety of a road concerning vehicle occupants, motorcyclists, pedestrians, and bicyclists, to name a few. The project involved a measurement of the star ratings at the baseline and ratings at the end of the project (iRAP 2011). The improvement of star ratings at the end of the project indicated an improvement in overall safety on the stretch (iRAP 2019).

b. Potential interventions are tested for their ability to reduce road crash deaths and injuries in each 100-meter section of road (iRAP 2011).

c. The economic effectiveness of each intervention is assessed through a benefit-cost ratio (iRAP 2011).

Quantifiable parameters such as a benefit-cost ratio of probable interventions set of interventions that promised the highest returns were selected and implemented by the Public Works Department with demonstrable success in reducing road crashes and deaths.

Figure 1.2: Speed management measures on the corridor (Source: IndiaRAP 2019)

1.3.2 Engineering

Multiple engineering issues, such as the unavailability of parking spots, lack of reflective road markings, to name a few, were identified (World Bank Blogs 2019). Then, at 40 major and minor intersections and 3 truck laybys, traffic signs, cycle tracks, thermoplastic bar markings (rumble strips), solar traffic signals, and raised pavement markers were placed across the stretch (IndiaRAP 2019). Further, the engineering interventions that were implemented were based on the results of the iRAP assessment. iRAP assigned star ratings to the road under the Star Rating for Design (SR4D) process, which led to informed decision-making in road engineering interventions (ITF 2022).

1. The iRAP baseline found that 5% of the investigated crashes on SH-20 occurred at intersections (JP Research India 2012). Therefore, seven intersections were provided with medians to avoid head-on collisions and channelize the traffic, additional

lanes for right-turning vehicles to avoid rear-end collisions, and splitter islands to allow pedestrians to cross safely (Swami and Kirori 2018).

2. The iRAP baseline study further noted that the investigated crashes on SH-20 were caused by inadequate pedestrian facilities at bus stops and buses parked at the side of the road (JP Research India 2012). The project also included improved facilities for pedestrians by including a bus stop with a lay-bye and a raised pedestrian crossing that included space for refuge in the median for safe crossing (iRAP 2019).

3. **Speed management:** The baseline study found that the 85th percentile speed in the Belgaum district was 24 km/h above the posted speed limit (i.e. 50 km/hr in urban areas and 60 km/hr in rural areas). Rumble strips were found to be unscientific and too high for small and medium-sized vehicles (JP Research India 2012). Vehicle speeds on all key intersection locations were reduced to roughly 40 km/h using speed calming measures, including raised (table-top) crossings placed on either side of the intersection and yellow painted stripes laid out across the road.

4. **Safety in hilly sections:** A 3 km-long hilly section on the stretch from Hanamana Hatti village to Karadiguddi village consisted of multiple sharp curves and hairpin turns. These sites required proper signage and safety measures for night time driving (Government of Karnataka 2014). Therefore, hill roads with bends and sharp horizontal curvatures were provided with delineation and '2+1 lanes' (iRAP 2019) for drivers' safe overtaking.

5. **Parking Facilities:** Baseline studies found that trailers, farm tractors, trucks, and buses parked on the narrow shoulder of the road were responsible for 31% of road crashes on SH-20. The narrow shoulders meant that the body of the parked vehicle encroached upon the carriageway leading to fast-moving vehicles colliding into them. The baseline study also analyzed a crash wherein a car hit a tree that was well off the road. Agricultural produce present on the road for drying or because of loading/unloading activities also increases the

risk of vehicles skidding off the road (JP Research India 2012). Therefore, parking facilities were arranged for freight vehicles, and metal crash barriers were installed to manage roadside hazards. The parking facilities and other safety improvements made in the road design and engineering improved the iRAP safety assessment of the road with minimal impacts on the project budget.

The project also involved long-term output and performance-based maintenance contracts (World Bank ICR 2019). These contracts included road safety considerations in the design and construction phase of the project (World Bank Blogs 2019). The project's maintenance contracts also included post-crash care considerations in the design and construction phase (ITF 2022).

1.3.3 Enforcement Measures

1. **Road-User Behaviour:** As per the baseline study, it was found that there were incidents of road crashes involving drivers under the influence of alcohol and speeding (JP Research India 2012). To counter drunk driving and overspeeding, police officials were equipped with breathalyzers, speed guns, digital cameras, interceptor vehicles, reflective jackets, and first aid boxes (IndiaRAP 2019). The police also focused on traffic violations such as non-usage of helmets and seat belts, use of mobile phones while driving, overcrowding in passenger buses and school vans, carrying passengers in goods vehicles, etc. (Swami and Kirori 2018).

2. **Capacity building:** Electronic enforcement was enhanced through capacity building of police departments through training and equipment support to ensure speed compliance (World Bank Blogs 2019). Police personnel were trained in the use of monitoring cameras to monitor vehicle speed and enforce speed limits (IEG Review Team 2019).

1.3.4 Education/Engagement

The community adjacent to the project road was trained to understand safer infrastructure, post-crash services, and police support. Community education measures included outreach through media brochures and short films, the presence of traffic wardens outside schools, setup of traffic parks, and operation of training institutes for drivers. A large communication campaign was organized to spread awareness among road users through videos, posters, pamphlets, and workshops (IEG Review Team 2019). Mass media campaigns were also carried out on platforms such as Facebook and Instagram (World Bank Blogs 2019).

1.3.5 Emergency Medical Care

Based on an In-Depth Interview (IDI) conducted with Dr. Gururaj Gopal, Senior Professor of Epidemiology at NIMHANS Bengaluru, the following information was gathered as regards the emergency medical care interventions carried out under the project:

1. **Comprehensive mapping:** A facility mapping exercise and inventory of medical care facilities was undertaken. This was followed by a gap assessment and efforts were made with the State government to bridge the gaps. The administration had to be geared up for all road safety aspects. As part of the assessment, medical colleges in the project districts were identified, and teams within each were created and trained. These teams developed and used questionnaires and instruments to identify the current status of trauma care facilities in project districts such as Hubballi, Dharwad, and Bagalkot. Four teams were subcontracted, supervised, trained, and monitored to undertake this task, collect data, and develop a final assessment report.

2. **Strengthening first care response and ambulance network:** Based on the recommendations of the assessment report, stakeholders working closely within the ambit of emergency

services in defined healthcare facilities such as doctors working in district hospitals, Taluk hospitals, primary healthcare centers (PHCs) were provided advanced, short-term training programs to better manage trauma cases including those related to road traffic injuries. This had a rollover effect as regards all trauma cases. Further, since a limited number of ambulances were available, there were problems in coordinating the movement of ambulances on the corridor. Efforts were also made to strengthen the network to reduce the response time of the ambulances through optimal placement of existing ambulances.

3. **Community preparedness:** The community near the corridor was trained in trauma care so that lay responders knew the importance of early response and safe transportation. People who frequently came in contact with road trauma victims, such as teachers, drivers, police personnel, and youth leaders, were prioritized for such training. A separate training of the trainers was also conducted for the district team, which, in turn, undertook training programs for community personnel.

A multi-tiered monitoring mechanism was also created. A State-level monitoring body headed by the Project Director of the Karnataka Health System Development and Reform Project (KHSDRP) was created. Its members included the State Health Secretary, the Director of Health Services, and key members of the EMRI 108 team. At the district level, the teams included the District Collector or District Superintendent, the District Health Officer, and the medical superintendents of the medical colleges nearby. The Project Director, KHSDRP, convened meetings at different levels to monitor the progress of the project (Gopal 2023).

A special road safety cell was also set up to prepare an annual road safety improvement program, and a budget proposal based on the data collected by the field offices and the police department. This spurred the government to provide a dedicated budget for "road safety works" in the fiscal year 2018-19, totaling INR 3.08 billion (USD 45 million). As of 2019, the program was being implemented by the field divisions of the road agencies (World Bank Blogs 2019).

1.4 TEAM STRUCTURE AND STAKEHOLDERS

The program involved the World Bank team of transport and road-safety specialists, road-safety engineers from iRAP, and the Karnataka PWD, together with government departments such as the Home (police enforcement), Health, Education and Transport departments (ITF 2022).

1.5 PROJECT FUNDING

The INR 628.9 million (USD 9.2 million) road safety project (IEG Review Team 2019) was jointly funded by the State Government of Karnataka and the International Bank for Reconstruction and Development (IBRD) from March 2011 to December 2018. This total funding included measures deployed under the four main road safety pillars, viz. road engineering, police enforcement, emergency medical care, and road safety education and awareness. The fund is distributed in the following manner:

- International Bank for Reconstruction and Development (IBRD): INR 499 million (USD 7.3 million).
- Government of Karnataka (GOK): INR 129.9 million (USD 1.9 million) (World Bank ICR 2019).

1.6 REPLICABLE PRACTICES

1. **Development, customization, & high-level monitoring of post-crash care:** The health department of Karnataka focused heavily on strengthening the entire chain of survival of post-crash care, i.e. on-site care, in-hospital care, and patient referrals. A network-based communication system was established between the Police and Health departments to provide guidance and simultaneous updates to both the caller and the relevant agency (KSHIP 2016). On-ground data was gathered to create a tailored implementation plan, and monitoring of the plan was conducted at the highest level via a State-level monitoring body which included the Project Director (KHSDRP), the State Health Secretary, the Director of Health Services, and key members of the EMRI 108 team (Gopal 2023). Other States can also adopt such monitoring mechanisms. A robust model for post-crash care monitoring also exists in Tamil Nadu, which will be discussed in detail in Case Study 13. To replicate this approach at a State-level, State Health officials can do a gap analysis of the chain of survival at stretches under ongoing and future road safety projects. The State government can then allocate funds, create infrastructure, and install the required human resources. States can also seek the expertise of emergency care personnel involved in past road safety projects for medical emergency preparedness.

2. **Institutional Strengthening and Improved Coordination between departments via regular meetings focused on corridor interventions:** Under the Karnataka State Highway Improvement Project II, the road sector institutions were strengthened with a detailed plan of action. The action plan was a major contributing factor to a 54% reduction in road crash deaths on the Belgaum-Yaragatti Corridor. Therefore, such plans are instrumental for the smooth implementation of the project without compromising safety and hence should be developed for road safety projects of a similar scale to the Karnataka road safety demonstration corridor. Further,

in this project, improved cooperation between the police, engineers, local administration, public representatives, transport operators, and health officials (World Bank Blogs 2019) was achieved by setting up a working group for the SCDP Belgaum project. This group met every month to discuss progress, challenges, and solutions concerning the project (KSHIP 2016). Similar working groups can further strengthen institutions at the ground level.

3. **Framing Contracts with in-built road safety considerations:** As part of the project, certain road safety considerations, such as post-crash care for crash victims, were integrated into performance-based maintenance contracts (World Bank Blogs 2019). Such contracts can be deployed in the design and construction stage of high-speed corridors.

4. **Efficient operation of dedicated State road safety budget:** The project included the establishment of a special road safety cell that initiated annual road safety improvement programs as well as a budget proposal based on field data collected by the field officers and police. This spurred the Government of Karnataka to provide a dedicated budget for future road-safety works. As per the Supreme Court Committee on Road Safety directions in 2016, all States must create a road safety fund for conducting road safety activities. While many States have established (MoRTH 2023) road safety funds, there are issues with the disbursement of funds in some States. For example, Maharashtra has reported under-utilization of its road safety budget (The Economic Times, 2023). The model in this project, in which the budget allocation was made through data-driven decision-making can be used as a reference for disseminating such funds.

5. **Decision on Suitable Road Safety Measures through Quantifiable Parameters:** Quantifiable parameters such as a benefit-cost ratio of probable interventions, can be assigned to ensure that the road safety measures that are most effective are deployed. During baseline studies, the BCR (benefit-cost

ratio) method used by iRAP for proposing interventions and alternate courses of action laid a clear path (iRAP 2013, 35). The set of interventions that promised the highest returns were selected and implemented by the Public Works Department with demonstrable success in reducing road crashes and deaths. Similar exercises can be conducted by other State governments to decide road safety measures within a project.

1.7 KEY LEARNINGS/ LESSONS LEARNED

1. **Informed Decision-Making Mechanisms for Road Safety Interventions:** At the planning stage, it was ascertained that the cases recorded by the police only included the driver error factor. This made the data insufficient to analyze the probable infrastructural or vehicular error factors. After the identification of this gap, a detailed crash analysis was conducted at the planning stage to ascertain the various factors involved in a road crash. The investigated crashes were a major factor in determining which interventions would yield maximum results in the project. Therefore, instead of only relying on police case data, a detailed crash analysis is necessary to determine the various contributing factors to a crash. Through the analysis, the most effective road safety measures can be chosen and implemented for maximizing reductions in road crashes and deaths.

2. **Evaluation of Timelines based on Target Jurisdiction:** It was ascertained that the design underestimated the time taken for some project activities, which were the first of its kind in Karnataka. There were delays in finalizing and awarding public-private partnership contracts, co-financing arrangements, and land acquisition, which contributed to a two-year extension of the project. These delays resulted in a shifting of project timelines. For achieving road safety targets in a time-bound measure, it is necessary to minimize such delays in the implementation phase. Therefore, no matter how similar previous projects and learnings were, the local context of the target jurisdiction needs to be taken into consideration for the effective implementation of the project.

Case Study 2:
KERALA

Kazhakoottam-Adoor Corridor (SH-1)
Safe Corridor Demonstration Project (SCDP)

The 80 km Kazhakkoottam-Thaikod-Kottarakkara-Adoor Corridor witnessed a total of 80 deaths in 2013. This translates to a higher number of deaths per kilometer than the national average (i.e. total number of deaths per km of State highways in 2013). Interventions across the 4E's were implemented on the stretch, which resulted in a 46% reduction in deaths from 2013- 2021. The project was managed by the Kerala Road Safety Authority (within the Public Works Department, Government of Kerala).

1 | KEY DATES: THE PROJECT WAS APPROVED ON 14 MAY 2013, AND COMPLETED ON 30 APRIL 2021(WORLD BANK ICR 2022)

2 | AREA COVERED: 80 KM STRETCH ON THE KAZHAKKOOTTAM-THAIKOD-KOTTARAKKARA-ADOOR CORRIDOR (SH-1) (PWD, GOVERNMENT OF KERALA 2020)

3 | IMPACT: REDUCTION IN ROAD CRASH DEATHS: ~46% FROM 80 DEATHS/YEAR IN 2013 TO 43 DEATHS/YEAR IN 2021; REDUCTION IN VRU ROAD CRASH DEATHS: ~49% FROM 49 DEATHS/YEAR IN 2013 TO 25 DEATHS/YEAR IN 2021 (WORLD BANK ICR 2022)

4 | SCOPE OF REPLICATION: THESE INTERVENTIONS CAN BE REPLICATED ON HIGHWAYS WITH SCHOOLS AROUND THEM AND ON HIGHWAYS THAT WITNESS HIGH FOOTFALL OF VRUs

Total and VRUs Road Crash Deaths: Kazhakoottam- Adoor Corridor
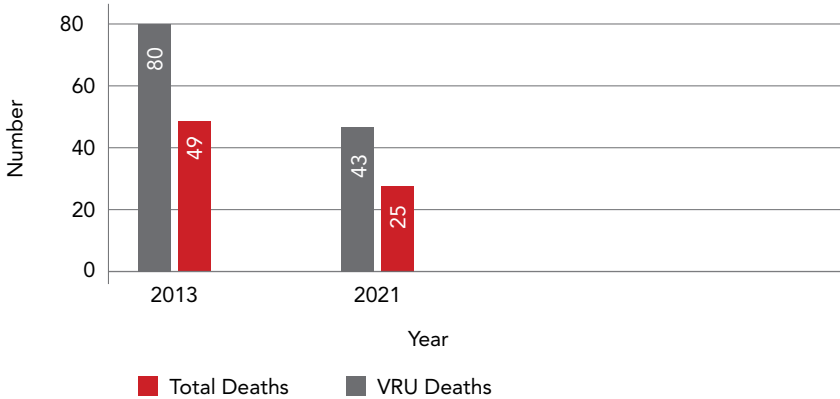
Graph 2.1: Total road crash deaths and VRU deaths between 2013 and 2021 on SH-1

2.1 ABOUT THE PROJECT

The Main Central Road (MC Road) in Kerala is an important pathway leading to popular eco-tourism and religious destinations (Tourism News Live 2020). Under the Second Kerala State Transport Project (KSTP-II) of the World Bank, an 80-km stretch of the MC Road passing through Thiruvananthapuram, Kollam, and Pathanamthitta districts was selected for a Safe Corridor Demonstration Project (SCDP). The corridor was first commissioned on June 18, 2020 (The Hindu 2020). While SCDP projects in Karnataka and Andhra Pradesh were held in urban settings, the Kerala SCDP was conducted in a "Rurban" or peri-urban context (World Bank ICR 2022).

1. Documents Reviewed:
a. iRAP India Phase 2: Kerala State Technical Report 2013
b. Monthly Progress Report, PWD, Government of Kerala, January 2021
c. NATPAC Annual Report 2018
d. NATPAC Annual Report 2019
e. IEG Review Team Report 2022
f. World Bank ICR Report 2022

2. For this case study, the Exchange rate effective is $1=Rs. 78.07 as on June 21, 2022, as mentioned in the World Bank ICR Report 2022

2.2 BACKGROUND

This project was undertaken because the stretch witnessed a high density of traffic (Average Annual Daily Traffic (AADT) over 10,000) (iRAP 2013) and road crashes had risen "even after the development of a 100 km of the road's southern course as per world standards in Phase I of KSTP" (The Hindu 2016).

It was also found from police records that 1159 road crashes, 229 crash deaths, and 1338 injuries had occurred between 2010 and 2012 in the 80 km road stretch from Vetturoad to near Adoor bypass ("TrafficInfraTech" 2013), which approximates the SCDP site. To put this in perspective, 16,808 crashes occurred between 2010 to 2012 (Chand 2017) on 4,341 kilometers of State Highways in Kerala (MoRTH 2013). Thus, the annual number of road crashes per kilometer for the corridor (4.8 crashes/km) was almost four times that recorded on State Highways in all of Kerala (1.3 crashes/km) during the same period.

In May 2012, the corridor was surveyed by Indian Road Survey and Management (IRSM), a private firm that provides topographic surveying services, using a "Hawkeye 2000" digital imaging system (iRAP 2013). Further, a joint venture between the Transport Research Laboratory and JP Research (TRL-JP Research JV) appointed by KSTP as a consultant, studied, inter alia, the iRAP and NATPAC report to prepare an enforcement strategy plan (PWD, Government of Kerala 2021).

Decision-Making Tools:
A pre-construction baseline study by iRAP in December 2012. (NATPAC 2014).

Enabler:
Agreement no. 276/KSTP/PMT/PWD/2016 dated 5th December 2016 awarding Safe Corridor work to GHV-EKK joint venture ("KSTP-II/SCDP" 2020)

Validation mechanism:
- The impact was identified with the help of an evaluation exercise conducted by the World Bank and documented in an Implementation Completion and Results (ICR) report published on June 21, 2021.

Figure 2.1: The 2 images above display the IRSM Survey vehicle used on the corridor (Source: iRAP 2013, 16)

2.3 INTERVENTIONS

According to the National Transportation Planning and Research Center (NATPAC), an iRAP assessment of the stretch in December 2012 revealed that 99% and 92% of the stretch was of the lowest star (single star) rating for road safety standards for pedestrians and bicyclists, respectively (NATPAC 2014). To mitigate the risks for all road users, specifically such vulnerable road users, the following interventions were implemented on the stretch:
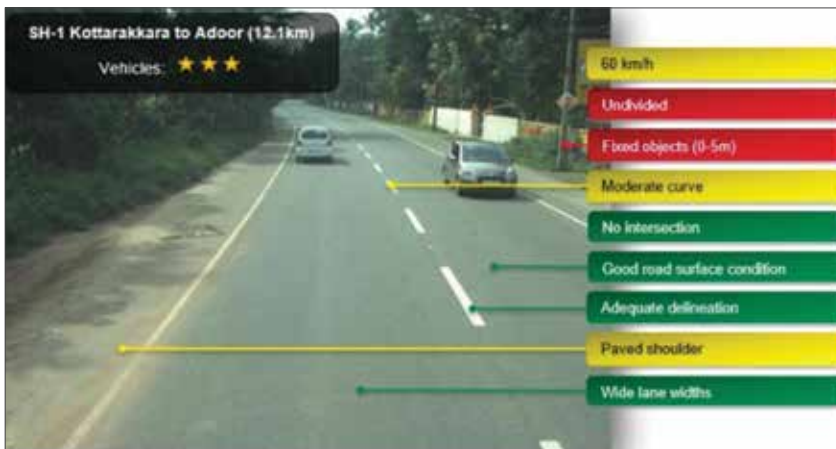
Figure 2.2: Road attributes observed in baseline studies on the corridor (Source: iRAP 2013, 29)

2.3.1 Engineering

Major interventions on the stretch included road signage, road marking, school zone improvements, street lighting, short-term intersection improvement plan, and provisions for bus stops (KSCSTE-NATPAC 2019). A total of 33 intersections were improved, 36 school zones were provided with gateway treatment, road markings and informative and precautionary sign boards were introduced on the safe corridor (The Hindu 2019, The New Indian Express 2020).

1. **Improved Road Delineation:** Of the 622 km of roads surveyed by iRAP in Kerala, it was observed that only 1% of the surveyed roads had separations between opposing flows of traffic (iRAP 2013). Therefore, yellow and white ladder lines were used to warn road users not to cross onto the other side of the road while driving (The Hindu 2019). Poor visibility on the stretch was addressed by installing solar street lighting (The New Indian Express 2020). Further, three-set deflector arrows were provided to caution drivers to return to their left lanes (The Hindu 2019).

Figure 2.3: Hazard markings on the safe corridor (Source: KSTP-II/SCDP 2020)

2. **Hazard Elimination:** The baseline study found multiple roadside hazards within 5 meters of the carriageway and limited roadside protection (iRAP 2013). Countermeasures such as crash barriers were then installed at vulnerable spots and Transverse Bar Markings (TBMs) were used to mark hazardous zones (The Hindu 2019). Rumble strips and signages were also installed to alert drowsy drivers leaving the road, to help them slow down and mind the road (The Hindu 2019).

Figure 2.4: Aerial view of the improved Kottarakara Intersection on the safe corridor (Source: KSTP-II/SCDP 2020)

3. **Intersection improvements:** As per the baseline survey, the intersections lacked protected turns and were mostly non-signalized and at grade (i.e. at the level of the road). A total absence of facilities for bicycles and motorcycles was also noted (iRAP 2013, 40). The project included the renovations of 33 intersections on the corridor(The New Indian Express 2020). Thirty major intersections were selected in the short-term intersection proposal and a classified traffic volume count was carried out on each. The intersection improvements, implemented with minimal land acquisition, included demarcated areas for bus stops, parking (both on- and off-street), proper signages, and safe pedestrian crossings to name a few (KSCSTE-NATPAC 2019). To ensure the safe right turn of vehicles, right-turn Protected Lanes and Yellow Box Markings were provided. As many as 85 black spots identified on the corridor were provided with special road markings (The Hindu 2019).

4. **School zone interventions:** The corridor had several schools nearby (KSCSTE-NATPAC 2019) and the baseline study found that only 5% of the surveyed roads had sidewalks for pedestrians (iRAP 2013). As a result, child safety was a major concern on the stretch. Therefore, gateway treatments were carried out in 36 of the 59 school zones (KSCSTE-NATPAC 2019) that had access to the demonstration corridor to improve both pedestrian and child safety (The Hindu 2020).

- The entire length of school zones, from start to finish, was provided with pedestrian guard rails and 2 meter-wide and 300-meter-long footpaths (The Hindu 2019).
- Second, the school zones were given road markings: zig-zag markings on the center line, white edge lines on both sides of the road, and yellow edge lines near the school gates with a 'School - keep clear' sign painted on the road (The Hindu 2019).

Figure 2.5: Aerial view of School Zone treatments carried out on the corridor (Source: "KSTP-II/SCDP" 2020)

- Third, every school was provided with a 3-meter-wide pedestrian crossing along with a PELICAN signal to ensure safe crossing. The crossing was followed by a stop line along with a "STOP" text on the road to alert drivers (KSCSTE-NATPAC 2019).

- Fourth, signboards indicating a speed limit of 30 km/hour, three sets of rumble strips at 50, 80, and 120 meters from the crossing, and "SCHOOL ZONE" markings in white were used on both approaches to control speeds. Before the crossings, the word "SLOW" was marked on the road along with small transverse yellow lines (The Hindu 2019). Student pick-up and drop-off areas were demarcated with proper markings. Cautionary and informatory sign boards for pedestrian crossings, bus bays, bus stops, and school zone boards were also provided (KSCSTE-NATPAC 2019).

5. **Modern road signage:** 3,897 sign boards were provided on the SCDP corridor as per IRC guidelines, and their dimension and placement were based on corridor speeds. A unique "Marking Information Signboard" was also installed to educate road users about the markings and what they meant, given such markings had not been previously used in the State (KSCSTE-NATPAC 2019).

Figure 2.6: A multi-utility vehicle used by the Motor Vehicles Department for patrolling the corridor (Source: The Hindu 2020, September).

6. **Community-informed design:** One of the unique recommendations of the survey was the advice to engage with local communities to maximize benefits accrued from the project - a research-backed good practice. Two-way information sharing between road authorities and local interest groups was suggested to ensure road users understand the use of the road network and to apprise designers and decision-making bodies of the needs of the population affected by the project (iRAP 2013). As recommended, consultations with vulnerable road users (VRUs) such as three-wheeler drivers, pedestrians, and bicyclists were conducted at 17 corridor intersections to assist in project design. NATPAC incorporated local opinion in its designs which led to the provision of multiple road safety features and bus stops along the corridor (World Bank ICR 2022).

2.3.2 Enforcement Measures

1. **Enforcement goals:** Baseline studies had revealed a list of traffic violations that could be a cause of road crashes on the stretch. In 2019, UK-based consultant, Transport Research Laboratory (TRL) prepared an enforcement strategy plan to

support the Safe Corridor project (Edwards 2021). As per the plan prepared by TRL, the primary objective was to create and ensure a highly visible traffic enforcement regime on the stretch. The perception of increased enforcement coupled with a diligent booking of traffic rule violations was to ensure behavior change among road users and in turn create better compliance with traffic rules. The task of patrolling the corridor was entrusted to an enforcement unit, supported by 9 police stations on the corridor (The Hindu 2020).

2. **Round-the-clock enforcement:** The enforcement unit comprised 8 teams (The Hindu 2020). A total of 13 enforcement vehicles, including 9 multi-utility vehicles (MUVs)/four-wheelers and 4 Bullets (motorcycles), equipped with the latest enforcement tools and manned by the police and Kerala Motor Vehicles Department personnel were deployed to patrol the stretch to ensure road discipline. These vehicles were also used to respond to emergencies in case of road crashes. The vehicles were procured at a cost of INR 8.9 million (USD 114,000). While 3 of the 9 four-wheelers were manned by the KMVD, the rest were assigned to police personnel (The Hindu 2020).

3. **Training activities:** TRL helped provide Training of Trainers (ToT) and enforcement training for Police and KMVD officers to ensure scientific, safe, and effective management of traffic on the corridor (The Hindu 2020, May). On May 7-8, 2019, at the Police Training College in Thiruvananthapuram, a two-day trainers' training for 27 Police and 7 MVD officials was held. From May 13 to June 18, 2019, a second two-day training was held at Jubilee Mandiram in Kottarakkara for 9 batches of 151 police officers and 21 MVD officers from 9 police stations and 5 MVD offices with authority over the project's covered areas (PWD, Government of Kerala 2021).

Figure 2.7: MLA Kottarakara formally inaugurating the Road Safety Education and Awareness Program in SCDP (Source: (KSCSTE-NATPAC 2020)

Figure 2.8: SRS program at Govt Higher Secondary School, Venjarammodu (left) and DB Higher Secondary School, Vamanapuram (right) (Source: KSCSTE-NATPAC 2020)

2.3.3 Education/Engagement

Formally inaugurated on September 19, 2019, NATPAC conducted the Road Safety Education and Awareness Program in SCDP for training various target groups such as the local community, school children, drivers, and youth within and outside the project area on the basics of life support and first aid, road safety, and traffic rules.

1. **SRS program in schools:** First inaugurated at St. Thomas Public School in Kattayikonam, the Safe Road to School (SRS) program involved the participation of 128 students and 13 teachers from 6 schools. In total, 13 such programs were conducted between November 11, 2019, and January 28, 2020, involving 1,395 students and 106 teachers from 39 schools in the project road districts (KSCSTE-NATPAC 2020).

2. **Outdoor campaign:** 21 programs were conducted as part of the outdoor campaign in the SCDP. Public meetings were held at important intersections on the stretch which included sessions on road markings, road safety, and regulations. Two street dramas "Yathrakkapuram" and "Signal" were played in all such locations, and pamphlets and leaflets were distributed among the participants. While "Yathrakkapuram" was played by professionals from the Folk Media Traffic Education Society, Thiruvananthapuram, "Signal" was created by the Kerala Police (KSCSTE-NATPAC 2020).

3. In 2015, India's first-ever road safety Hackathon was jointly organized by the World Bank and the Kerala Road Safety Authority on August 22-23 (The New Indian Express 2015), involving 150-200 developers working to develop technology and solutions for road safety (World Bank 2015).

2.3.4 Emergency Medical Care

The post-crash care on the project roads was improved by the Kerala State Transport Project (KSTP). To improve emergency care services, the Kerala government's Department of Health and Family Welfare originally created a plan. The idea called for the purchase of Advanced Life Support (ALS) ambulances as well as an upgrade of trauma care facilities at five public hospitals located close to the route.

1. Hospital upgradation was conducted as part of the project - Level 1 and Level 2 hospitals—which offer the highest and second-highest levels of trauma care—were updated fully while Level 3 hospitals were given updated medical equipment. The hospitals equipped under the project included Government Medical College (MCH), Thiruvananthapuram; Taluk Headquarters Hospital (THQH), Kottarakkara; Government General Hospital, Adoor; Community Health Center (CHC), Kanyakulangara; and Block Primary Health Center (PHC), Vamanapuram (PWD, Govt. of Kerala 2020). This was done at a

total cost of INR 282 million (USD 3.6 million) (The New Indian Express 2020). Civil works such as providing false ceilings and aluminum windows in trauma care wards and electrical works such as providing trauma care wards with air conditioning and adequate electrification were also carried out. Further, two ambulances equipped with state-of-the-art equipment were also procured for Adoor General Hospital and Taluk Headquarters Hospital, Kottarakara at a cost of INR 6.39 million (USD 81,850) (PWD, Govt. of Kerala 2020).

2. A Technical Committee comprising four members was also constituted by the Health Department to assist the Kerala Medical Services Corporation Limited (KMCL) in equipment procurement and management. The members included staff of various hospitals selected for the upgrade (The New Indian Express 2018).

3. Equipment such as Ventilators, Centralized Medical Gas Systems, Anesthesia Workstations, CT Scanners, Ultrasound with Colour Doppler, and Flash Autoclave were also procured for Level 1 and Level 2 hospitals. Specifically in Trivandrum MCH, emergency trauma care equipment provided under the project included a Neuro Navigation System, CT Scanner, Operating Microscope, Surgical Instruments, and 30 other types of medical equipment (PWD, Govt. of Kerala 2021, January).

4. To ensure that enforcement officials while patrolling the stretch can also ensure quick response time, enforcement vehicles were also equipped with first-aid and extraction kits for enforcement personnel to break glass or cut seat belts to remove vehicle occupants in case of emergencies (The Hindu 2020, May).

Apart from the multi-sectoral interventions at the corridor, the project helped set up a Challenge Fund (CF) for replicating the good practices gathered from the safe corridor project in multiple other districts and improving district-level road safety management capacity (World Bank ICR 2022), a first for a State highway project in India (IEG Review Team 2022).

Another highlight of the project was the establishment of a Technical Support Group (TSG) within the Road Safety Authority, which was itself formed within the Public Works Department (PWD) under KSTP-1. The TSG acted as KRSA's secretariat for overall road safety management. The TSG vetted the enforcement action plan for the project, created templates for submissions to the Challenge Fund, formulated a project monitoring and evaluation (M&E) framework, and helped with community consultations (IEG Review Team 2022).

2.4 TEAM STRUCTURE AND STAKEHOLDERS

The project was managed by the Kerala Road Safety Authority (within the Public Works Department, Government of Kerala), various stakeholder departments included the Kerala Motor Vehicles Department, Kerala Police Department, Ministry of Health and Welfare, Government of Kerala, Transport Department of Kerala, Kerala Medical Services Corporation Limited (KMCL), and Department of General Education, Government of Kerala (The New Indian Express 2018).

2.5 PROJECT FUNDING

The project cost about INR 1.79 billion (USD 22.9 million) in total. (PWD, Govt. of Kerala 2021, January). This total funding included measures deployed under the four main road safety pillars viz. road engineering, police enforcement, emergency medical care, and road safety education and awareness.

2.6 REPLICABLE PRACTICES

1. **Implementation of engineering interventions in accordance with the findings of surveys:** The engineering interventions for the Kazhakoottam-Adoor Corridor were determined based on the findings of the baseline survey. The survey identified areas where improvements were needed, such as intersections

lacking protected turns and having no signals or being at-grade. To address these issues, the project included the renovation of 33 intersections. A similar approach was taken by Karnataka for the Belgaum-Yaragatti corridor as well and can be replicated on other State highways.

2. **Establishment of Safe School Zones:** The Kazhamuttam Adoor Corridor project took into account the presence of several schools nearby and implemented measures to prioritize the safety of children during their daily commute. They installed appropriate signs and speed limit indicators near schools, constructed pedestrian guardrails and footpaths in school areas. These interventions can serve as a model for implementing similar safety measures near schools in other locations, thereby ensuring a secure journey to school for students.

3. **Engagement of local communities and stakeholders:** The Kerala SCDP involved consulting different categories of road users such as school children, faculty, neighborhood residents, and Vulnerable Road Users who frequently commute on the stretch to incorporate their opinions in the road design (IEG Review Team 2022). Incorporating such opinions in road design boosted project effectiveness and inclusivity in decision-making. Further, the involvement of NATPAC - a local planning agency and think tank, directly led to better road safety outcomes for VRUs on the corridor. As a result of NATPAC's inclusion of bus stops and other VRU provisions to the design, VRU deaths dropped by 49% between 2013 and 2021(World Bank ICR 2022). Therefore, future road safety projects, regardless of scale, within and outside Kerala should have a community inclusion component to mobilize local opinion and expertise. A decentralized, bottom-up approach of community consultations can be used to inform road safety project design, and the designs themselves can be prepared with the help of local agencies.

2.7 KEY LEARNINGS/LESSONS LEARNED

1. **Coordination between authorities for effective utilization of Challenge Funds:** The Challenge Fund was a first-of-its-kind fund implemented to strengthen road safety by replicating and scaling up good practices in a certain district to several districts. The fund was created to encourage district road safety councils to create proposals for improving road safety measures in their districts. Once the project was implemented the KRSA, through the Challenge Fund, would scale up the project. The Challenge fund was implemented to promote a bottom-up approach to road safety. However, due to the lack of capacity of the districts to send proposals to the KRSA, and the lack of capacity-building activities under the fund, the challenge fund was deemed an unsuccessful initiative (World Bank ICR 2022). For better implementation of the challenge fund in the future, systematic training and consultations should be conducted for districts, and a competition for submitting proposals could be arranged to incentivize districts to prepare good quality proposals. A more systematic capacity-building and training approach can help smooth the implementation of the challenge fund in the future.

2. **Assessment of the resilience of road infrastructure as part of road safety:** While the safety of road infrastructure in Kerala was being improved under the project, in 2018, unprecedented rains brought in its wake devastating floods and landslides across the State. This impacted the effectiveness of the project, and the Kerala Government realized that such climatic factors needed to be taken into consideration while deploying road safety interventions. The Kerala government then encouraged the addition of a new project component to address climate risks that affect road safety infrastructure and implemented the same (IEG Review Team 2022). Assessing climatic conditions can enhance informed decision-making, hence aiding in choosing the most suitable interventions.

Case Study 3:
MAHARASHTRA

Old Mumbai-Pune Highway (NH-48)

The 111 km stretch on the Old Mumbai-Pune Highway witnessed a high number of road crash fatalities i.e. approximately six times higher than the road crash deaths per km witnessed on the national highways in the country. Interventions across the 4E's were implemented on the stretch, which resulted in a 61% reduction in deaths from 2018-2021. The project's implementing agency is the Maharashtra State Road Development Corporation.

1 | KEY DATES: THE PROJECT WAS APPROVED ON 31ST DECEMBER 2018, COMMENCED ON 1ST JANUARY 2019, AND IS ON-GOING (MSRDC 2023)

2 | AREA COVERED: 111 KM STRETCH ON THE NH-48

3 | IMPACT: REDUCTION IN ROAD CRASH DEATHS: 61% BETWEEN 2018 AND 2021

4 | SCOPE OF REPLICATION: THE INTERVENTIONS UNDER THIS PROJECT ARE BENEFICIAL FOR HIGH-SPEED NATIONAL HIGHWAYS THAT ARE NOT ACCESS-CONTROLLED AND SEE A LOT OF MOVEMENT OF VILLAGERS AND OTHER INHABITANTS

Road Crash Death - NH 48
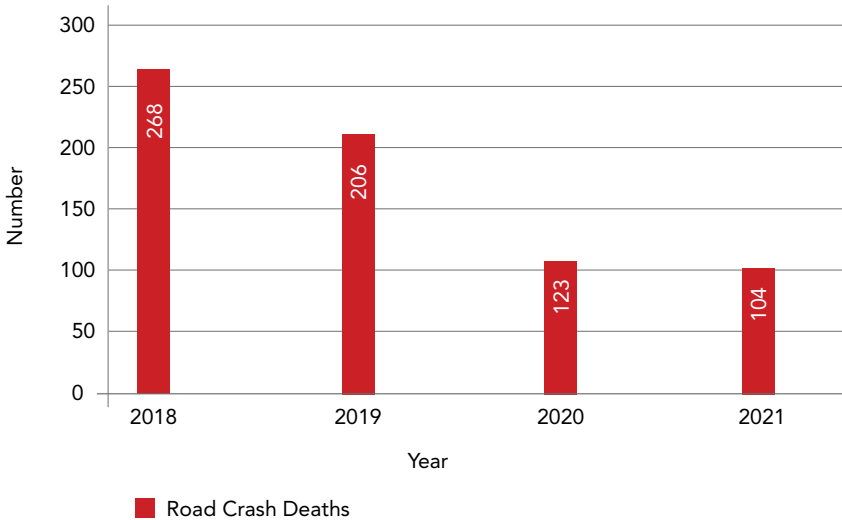
Graph 3.1: Road crash deaths on NH-48
(Source: Response from the Maharashtra State Road Development Corporation (MSRDC) Ltd.)

3.1 ABOUT THE PROJECT

The Zero Fatality Corridor (ZFC) is an effort to build a replicable model for road safety that can be implemented on any highway. The ZFC initiative is executed by implementing a 360-degree road safety solution across the 4 E's of Road Safety - Engineering, Enforcement, Emergency Care, and Education. The following are the key components of the ZFC (SaveLIFE Foundation 2023):

- Coalition Building: is the first step in achieving the goal of a ZFC project. The coalition of stakeholders introduces and implements critical decisions under one umbrella.
- Data Triangulation: A process that helps identify the risk factors. Data from the various agencies (police FIR report, crash record from the concessionaire, injury report, other investigation reports, hospital, ambulance) helps triangulate safety issues. Data triangulation also reveals baseline fatality data which is crucial to define project Key Performance Indicators (KPIs). It also helps to identify the intervention measures.

1. Documents Reviewed: State Questionnaire answered by the Joint Managing Director, MSRDC, 2023

2. For this case study, the average exchange rate for 2023 (until July 2023), where $1=Rs. 82.2 has been considered

- On-site Audits: include identification of infrastructural issues, locating roadside hazards, conducting scientific forensic crash investigations, conducting hospital and emergency vehicle audits, analyzing road users' behavior, unsafe activities, and examining road safety awareness of the road users to understand the significant safety issues of the project highway. This understanding grants insight into the nature of crashes and forms the backbone of the safety recommendations.
- Solution Deployment: proposes safety interventions based on investigated and international good practices. ZFC undertakes trials for novel countermeasures when existing safety countermeasures are unavailable or ineffective. Countermeasures fall under one of the 4 E's of road safety: Engineering, Enforcement, Emergency Care, and Engagement.
- Impact Measurement: reveals the progress and success of the project. The primary impact measured for the ZFC is the reduction in deaths. Continuous monitoring of the ZFC through internal and independent research measures the impact of the model.
- Replication: The goal of the ZFC is to save lives. Achievement of this goal is possible only when there is a replication of the findings of the ZFC. Such replications create more ZFCs to achieve safer roads.

3.2 BACKGROUND:

Before the inception of the project, in 2018, the Mumbai-Pune section of NH-48 suffered 268 road crash deaths, translating into 2 deaths per kilometer of the stretch, making it one of the deadliest roads in the country. The Government of Maharashtra in partnership with an NGO and a CSR partner implemented the Zero Fatality Corridor (ZFC) project on the NH-48. The Maharashtra State Road Development Corporation (MSRDC), which acts as a concessionaire on the Old Mumbai-Pune Highway, spearheaded the execution of ZFC interventions on the stretch and worked across the 4Es of road safety-Engineering, Enforcement, Emergency care, and Education.

Decision-Making Tools: Road Safety Audits, Data from police FIR report, crash records from the concessionaire, injury reports, hospital and ambulance data

Enabler: Memorandum of Understanding dated 31st December, 2018 between Maharashtra State Road Development Corporation (MSRDC) and an NGO focused on Road Safety

Validation Mechanism: The FIR data maintained by the Maharashtra Police was the main source of data

3.3 INTERVENTIONS:

To obtain more details on the implementation of the good practices across the 4 E's of road safety (i.e. Engineering, Enforcement, Education, and Emergency Care), a questionnaire was sent to the Maharashtra State Road Development Corporation(MSRDC) Ltd. The response was shared by Mr. Sanjay Yadav, the Joint Managing Director of MSRDC.

3.3.1 Data Analysis

Crash Vulnerability Audit (CVA): In the reporting period, a CVA report was prepared by the project's NGO partner and submitted to all relevant stakeholders. CVAs are a thorough check-up of the strength of the diverse road safety pillars at a specific stretch of road, which, unlike general audits, are not restricted to road engineering. CVAs include comprehensive and regular auditing techniques that also study concerns such as the availability and quality of emergency care and police enforcement. A CVA is an in-depth audit across the 4 Es of road safety, road engineering, police enforcement, emergency care, and public education and awareness. Various factors such as speed, road user behavior, traffic volume count and composition, patrolling details, ambulance, and hospital status, awareness of road safety protocols, etc. were captured during the audit. The current on-site audits undertaken by agencies such as the NHAI according to IRC:SP:88-2010 (IRC 2010) only focus on engineering issues. However, CVAs cover all the 4E's of road safety, thus giving a holistic picture of the road safety scenario on the ground. On 21st April 2022, the latest CVA report was completed and presented to the MSRDC. MSRDC and Highway State Police (HSP) reported that they have committed to implementing the various measures listed in the report (MSRDC 2023).

The following were the issues identified during the audit (MSRDC 2023):

- A total of 9,903 road engineering issues were identified during the audit. Some of them were:
  - Absent, damaged, and inappropriate termination of crash barriers
  - Vision obstruction along the stretch including signages covered by vegetation and obstruction at curves.
  - Absent and incorrect road signages
  - Absent delineation
  - Poor provision of pedestrian infrastructure.
- Enforcement issues such as the absence of designated, visible and skilled patrolling, pedestrians crossing the median, and lack of compliance with respect to safety device usage were also identified.
- Emergency care issues such as poorly maintained ambulances, inadequate infrastructure for post-crash care, and the lack of implementation of a pre-hospital notification system.

Additionally, 47 Forensic Crash Investigations for mass fatality crashes to analyze the various causes of road crashes were also conducted. Based on the response, shared by Mr. Sanjay Yadav, Joint Managing Director, MSRDC, the following interventions were implemented on the Old Mumbai-Pune Highway from 4th November 2019 (MSRDC 2023).

3.3.2 Engineering

1. Between 2019 and 2022, 10 Road Safety Audits were conducted across the stretch to assess engineering issues.
2. As of 2022, of the 9,903 engineering issues identified during the CVA, over 3,138 engineering issues have been rectified.
3. Installation of 385 Chevron signs and 1500 road studs around sharp curvatures: Chevron markers and road studs were installed to warn road users of oncoming dangerous or sharp road curvatures.

4. Identification and Treatment of High-Fatality Zones: Based on the CVA, certain parts of the stretch (each of them about 5 km in length) were identified as high-fatality zones. Engineering measures on these stretches were prioritized and measures for the treatment of these stretches were adopted.

5. Eradication of two blackspots: Two Blackspots on the highway were rectified by installing several road infrastructures such as crash barriers, median gaps, and so on. This also included rectification of the 300-500 meter stretch around the location as well.

Figure 3.1 Ambulance Informatory Sign at Lonavala
Source: Maharashtra State Road Development Corporation Limited

Figure 3.2 Speed Limit Signages at Anda Point on NH-48
Source: Maharashtra State Road Development Corporation Limited

6. Appropriate and visible signages: Appropriate and visible signages were installed across the highway. Such signages included emergency sign boards (34), pedestrian signages (10), speed limit signages (10), information signages (2), and no overtaking signages (2).

7. Tactical Redesign at Karla Phata Intersection: Karla Phata on the Old Mumbai-Pune Highway (NH 48) witnessed heavy pedestrian footfall with over 250 pedestrians using the intersection during the peak hour in December 2020 (Times of India 2021). In 2020, until October, 1 road crash and 2 injuries were recorded. The site was selected to determine the best design solutions to save the lives of vulnerable road users based on crash analysis (MSRDC 2023). This was the first highway intersection in the country where high-visibility paint and soft barricading were used to test a methodology to treat high-risk intersections on national highways. The Tactical Redesign included temporary equipment and materials for design and infrastructural changes to the layout of the intersection, to make it safer.

The temporary interventions were undertaken for a month (17 December 2020 to 17 January 2021). (MSRDC 2023). During the trial period, the intersection witnessed zero deaths and serious injuries. The intervention led to the following impact:
• 40% reduction in pedestrian exposure and reducing pedestrian vulnerability to conflict, crashes, and near-crashes.
• 22% overall reduction in overall speed at the intersection, making it safer for all road users.
• 20% reduction in overall conflict at the intersection between various motorized and non-motorized road users.
• 231% increase in the public realm, which includes pedestrian walkways, that ensure safe passage for pedestrians.

- 383% increase in the refuge area, including pedestrian refuge and vehicular refuge.
- 100% of the road users, including pedestrians and drivers, felt safe while crossing the intersection.
- 275% increase in the number of pedestrians using the existing footpath (MSRDC 2023).

The following interventions were undertaken:
- 150 traffic cones, 26 safety barriers, 136 road studs, and over 250 liters of paint were utilized to ensure safer mobility and refuge space for vulnerable road users over nearly 1200 square meters of the intersection.
- 45 hours of on-site video data were collected for surrogate safety calculations for conflict assessment at Karla Phata.
- Speed reduction: The interventions included vertical signages and speed limit markers to alert the drivers of the upcoming intersection almost 50 meters before it so that they begin reducing their speed.
- Safe public realm and pedestrian crossings: Interventions included an additional dedicated waiting area for pedestrians and improvement of the carriageway and crossing as per user requirements. The pedestrian crossings were marked with the help of synthetic enamel paint and helped reduce the exposed walking distance covered on the road by the pedestrian.
- Safe road geometry: All the roads along the intersection were corrected through changes in road geometry using bollards and barricades. Alongside the public realm, the respective shoulder spaces were widened, and the existing traffic triangle was redefined.

Figure: 3.3 Safe space for the movement of pedestrians (source: SaveLIFE Foundation)

- Space for public transport: A new bus stop was proposed considering the location and available space at the intersection (MSRDC 2023).

The Redesign measures were found to successfully create an improved scenario of safe mobility, which was visible throughout the intersection. 100% of the road users, including pedestrians and vehicular drivers, felt safe while crossing the intersection (MSRDC 2023).

3.3.3 Enforcement Measures
1. Deployment of 50,000 km of active patrolling by two Smart Patrolling vehicles focused on crash prevention.
2. Installation of two-speed traps installed for electronic enforcement.
3. Enhanced rear seat belt enforcement at two highway toll plazas (MSRDC 2023).

3.3.4 Education/Engagement
1. Two radio campaigns were conducted for creating awareness around road safety.
2. Audio messages were broadcasted at Toll Plazas in five languages to generate awareness regarding good road user behavior (MSRDC 2023).

3.3.5 Emergency Medical Care

1. An emergency care survey was conducted through an audit of seven hospitals and four 108 Emergency Care Service Ambulances. Based on the audits, recommendations were made to improve the infrastructure of emergency medical care on the highway.

2. As of 2022, 1,027 Police Personnel have been trained in Basic Trauma Life Support (BTLS), which provides bystanders with training in basic first aid, Cardiopulmonary Resuscitation (CPR), and bleeding control techniques, necessary to stabilize road crash victims before they are taken to the hospital (MSRDC 2023).

3.4 TEAM STRUCTURE AND STAKEHOLDERS

The staff allocated for the implementation of the project ranged across spheres and included administrative officers, engineers, medical staff, and on-ground daily wage workers. The team comprised members from MSRDC, Maharashtra Highway Police, NGO partners, and State Road Transport Office, all working in close coordination.

3.5 PROJECT FUNDING

The project was jointly funded by the Maharashtra State Government and the Corporate Social Responsibility funds of a private auto firm. The total funding included measures deployed under the four main road safety pillars viz. road engineering, police enforcement, emergency medical care, and road safety education and awareness. The Tactical redesign at the Karla Phata intersection was implemented through Corporate Social Responsibility funds amounting to INR 17 lakhs (MSRDC 2023) or USD 20,681.

3.6 REPLICABLE PRACTICES

1. **Conducting Crash Vulnerability Audits (CVAs):** Highway stretches can be audited at least once a year in-depth based on the 4 E's of road safety to identify safety issues and recommend appropriate measures. Generally confined to an assessment of the quality of road engineering, CVAs are a thorough check-up of the strength of the diverse road safety pillars at a specific stretch of road. To this effect, States can train road safety auditors in comprehensive and regular auditing techniques that also study concerns such as the availability and quality of emergency care and police enforcement. This will allow informed and targeted interventions to be taken up to reduce the number of road crashes. Institutionalization of these audits will further enhance the safety of roads in India. Similar audits take place on all ZFC stretches i.e. MPEW, YEW, etc. The current on-site audits undertaken by agencies such as the NHAI according to IRC:SP:88-2010 (IRC 2010) only focus on engineering issues. However, CVAs cover all the 4E's of road safety, thus giving a holistic picture of the road safety scenario on the ground. Therefore, CVAs should be adopted by all States for a multi-pronged approach towards road safety.

2. **Prioritising High-Fatality Zones rather than Black Spots:** The common approach on blackspots tends to rely heavily on historical crash data at a specific spot on the road. Conversely, the project involved regular analysis of crashes and the causes behind the deaths on a 5-kilometer-long stretch designated as a high-fatality zone. This is done as part of the CVA, which is based on data triangulation of FIR data, speed data, traffic volume, and blackspot data to name a few. Based on the

data, the 5 km stretches are identified and designated as high fatality zones. Further, the "blackspot" analysis also includes not only the location but the 500 m stretch around the location as well. Therefore, State governments should not target just a black spot, rather they should consider a larger stretch of road, and audit and deploy corrective measures on the same. This ensures that blackspots as well as nearby areas are made safer.

3. **Conducting Tactical Urbanism for Unsafe Intersections on Highways:** Tactical Urbanism refers to the deployment of low-cost and temporary interventions such as cones and barriers to reallocate the road space on a spot (could be high-fatality stretch or intersection) to protect pedestrians and non-motorized transport users from exposure to fast-moving vehicles, and reduce speeds, hence improving the overall safety of the zone or intersection. The redesign of Karla Phata on NH-48 was the first such project on a national highway in India. A similar redesign can be done across certain high fatality spots in India that witness high levels of mixed traffic. Through tactical urbanism, temporary interventions are tested out. The interventions that most significantly reduce the probability of crashes can be made permanent to augment the safety of the spot.

Case Study 4:
MAHARASHTRA

Yashwantrao Chavan Expressway Mumbai-Pune Expressway (MPEW)

The 94.5 km stretch on the Mumbai-Pune Expressway witnessed 159 deaths per 100 kilometers in 2016, which is higher than the national average of deaths on national highways i.e. about 50 deaths per 100 km in the same year. Interventions across the 4E's were implemented on the stretch, which resulted in a 40% reduction in deaths from 2016-2022. The project's implementing agency is the Maharashtra State Road Development Corporation.

1 | KEY DATES: THE PROJECT WAS APPROVED AND INITIATED ON FEBRUARY 23, 2016, AND IS ON-GOING

3 | IMPACT: REDUCTION IN ROAD CRASH DEATHS: 40% BETWEEN 2016 AND 2022

2 | AREA COVERED: 94.5 KM STRETCH ON THE MPEW (MSRDC 2023)

4 | SCOPE OF REPLICATION: THE INTERVENTIONS UNDER THIS PROJECT ARE BENEFICIAL FOR HIGH-SPEED ACCESS CONTROLLED ROADS THAT HAVE VARIED TOPOGRAPHY

Road Crash Deaths - MPEW
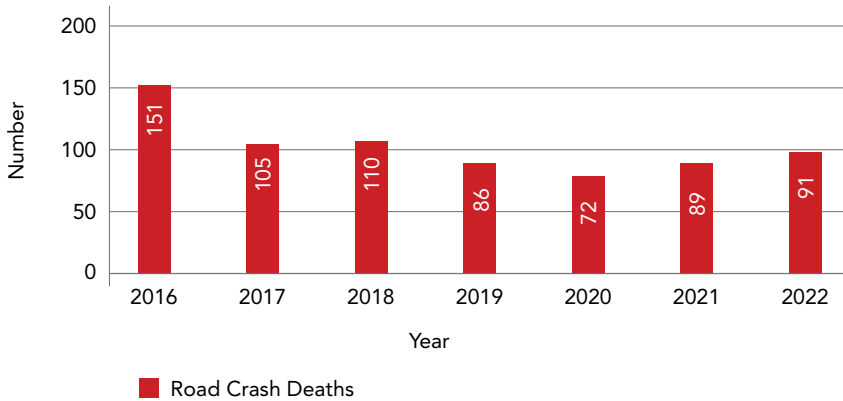
Graph 4.1: Road crash deaths on MPEW vs Year (2016-2022)
(Source: Data from the Maharashtra highway safety project)

4.1 ABOUT THE PROJECT

In 2016, the ZFC project was deployed on the 94.5 km stretch of the Mumbai-Pune Expressway, which is officially known as Yashwantrao Chavan Expressway. This Expressway is the country's first six-lane wide, access-controlled Expressway. It stretches from Kalamboli Town, Navi Mumbai to Kiwale Town, Pune, and passes through the Sahyadri mountain ranges as well as several tunnels (News18 2023).

4.2 BACKGROUND

The Mumbai Pune Expressway reported an annual average of 3 deaths per 2 km in 2016, totaling 151 deaths in the year (SaveLIFE Foundation 2023) . Moreover, the road crash severity on MPEW, (measured as deaths per 100 crashes), was 40.5 in 2016 whereas the national average for that year was 31.4 (MoRTH 2018). Therefore, this was one of the deadliest roads requiring urgent intervention.

Decision-Making Tools:
Audits, forensic crash investigation, electronic enforcement tools such as speed traps

Enabler:
Memorandum of Understanding dated 23rd February, 2016 signed between MSRDC and an NGO focused on Road Safety

Validation mechanism:
The FIR data by the Maharashtra Police and data published by Maharashtra Highway Police.

1. Documents Reviewed:
a. Questionnaire answered by Mr. Sanjay Yadav, the Joint Managing Director, MSRDC, 2023

2. For this case study, the average exchange rate for 2023 (until July 2023), where $1=Rs. 82.2 has been considered

4.3 INTERVENTIONS

To identify the reasons for crashes and deaths on the expressway, onsite audits and forensic crash investigations were conducted. To obtain more details on the implementation of the good practices across the 4 E's of road safety (i.e. Engineering, Enforcement, Education, and Emergency Care), a questionnaire was sent to the Maharashtra State Road Development Corporation(MSRDC) Ltd. The response was shared by Mr. Sanjay Yadav, the Joint Managing Director, MSRDC.

4.3.1 Data Analysis

4.3.1.A Crash Vulnerability Audits

Similar to the CVAs conducted on the Old Mumbai-Pune Expressway, CVAs were also undertaken on the MPEW to plan commensurate interventions. Two road assessment surveys were conducted in 2016 and 2018, respectively. Additionally, a comprehensive crash vulnerability audit was undertaken in 2022. These comprehensive assessments, backed by in-depth crash data, involved video recording the entire 94.5km of the Expressway on both carriageways (a total of 189 km) and a detailed kilometer-by-kilometer assessment to identify infrastructural factors leading to crashes and injuries. The three steps involved in the process are

1. Identification of errors (through Road Assessment Surveys).
2. Implementation of solutions (by MSRDC, NGO, and Highway Police).
3. Evaluation of work done (through onsite audits).

Four quarterly road safety audits were also conducted to highlight safety issues to help identify engineering issues. The road safety audits helped identify 3,500 engineering issues, of which 2,800 were rectified.

4.3.1.B Forensic Crash Investigation

Forensic Crash Investigation is a method to obtain evidence from the crash scene and the crash vehicle. Such evidence includes "skid marks, fluid spills, and struck objects" (NHTSA 2018). Through data-driven research and forensic crash investigations, the "why, where, when, and how crashes took place on the expressway" can be ascertained (SaveLIFE Foundation 2023). As of 2022, 500+ crashes have been investigated to identify the behavioral, vehicular, and infrastructural aspects associated with them (MSRDC 2023).

To obtain detailed information on the implementation of the good practices across the 4 E's of road safety (i.e. Engineering, Enforcement, Education, and Emergency Care), a questionnaire was sent to the Maharashtra State Road Development Corporation (MSRDC) Ltd. The response was sent by Mr Sanjay Yadav, Joint Managing Director, MSRDC. Based on the response, the following interventions were found to be implemented on the Mumbai-Pune Expressway from 2016 onwards:

4.3.2 Engineering

1. 29 construction zones were treated to make them safer for road users.
2. The following installations took place on the MPEW for the overall improvement of the road infrastructure:
   a. Installation of crash barriers: over 300 km of crash barriers have been installed across the edge and median side of 94.5 km expressway.
   b. Installation of Tactile Edge Line (TEL): 200 km of Tactile Edge Line (TEL) was installed on both sides of the carriageway to deal with the issue of driver fatigue.
   c. Installation of Speed Traps: 4 active speed traps and 1 mobile Variable Messaging Sign (VMS) were installed.
   d. Installation of "No Parking" Zones: No Parking Zones were installed at critical locations on the Expressway using paint to educate drivers about the No parking/No stopping on the Expressway.

e. Installation of speed marking: 24-speed markings were installed on the ghat section to inform drivers about the speed limit in the ghat section.

f. Installation of Chevron sign: Installed 94 Chevron sign boards at 31 sharp and dangerous curves, 8 S-shaped curve ahead signs, and 8 warning sign boards to warn commuters.

g. Installation of Rumble strips: Between Kilometer-45 and Kilometer-43 of the expressway, 6 sets of rumble strips were installed to wake up drowsy drivers and prevent fatigue crashes.

h. Tactile Shoulder Lines have been installed in certain sections of the expressway (3 km).

i. Warning sign boards for speed cameras, crash-prone zones, and information signs for truck rest stops have been installed.

j. Installation of blinkers on the median gaps to increase visibility.

k. Removal of potholes on the median of the expressway.

4.3.3 Enforcement Measures

1. Interceptor vehicles were placed at High Fatality Zones for active visible enforcement. Policemen patrolled in patrol cars provided by the associated NGO as an added enforcement

Figure: 4.1. Interceptor Vehicle at the MPEW (source: SaveLIFE Foundation)

measure. These steps helped in reducing crashes resulting from wrong-lane driving and vehicles parked in an unauthorized manner. Through active patrolling on the Expressway, 49,937 potential rear-end collisions were prevented.

2. Two Smart Patrolling vehicles focused on prevention of rear-ending crashes were dedicated to the MPEW.

3. Signage on uniform speed limits at the ghat section of the expressway (16 km): While uniform speed limits were notified by the Additional Director General of Police, Maharashtra Highway Police, the highway had different speed limits posted along the ghat section. The non-uniform speeds ranged from 30 km/hr - 50 km/hr and resulted in differential vehicle speeds. These differential speeds saw 29 deaths due to moving rear-end crashes between March 2021 and February 2022. The speed limit sign boards were made uniform and consistent with a speed limit of 50 km/h, which then resulted in 31% reduction of fatalities between March 2022 and February 2023. The speed signage was also augmented with chevron markings at each and every curve on the expressway. This signage also contributed to the reduction of rear-end crashes in the section by preemptively communicating the sharpness of the curve with the driver.

4. Rear seat belt enforcement has been undertaken at two Expressway toll plazas

5. Speed Traps have been installed to capture speeding violations on the MPEW (Times of India 2021). So far, two fixed speed traps and three Actively Relocatable Speed traps have been installed on the Expressway.

6. One Vehicle Activated Speed Sign (VASS) was deployed on the MPEW to measure vehicle speeds in real-time as they passed through the stretch.

Figure: 4.2. VASS at the MPEW (source: SaveLIFE Foundation)

4.3.4 Education/Engagement

1. Anticipatory Driving and Accident Prevention Training (ADAPT) Training - 263 commercial drivers including HMV and fleet drivers have been trained in crash prevention and anticipatory driving techniques.
2. 2,500 truck drivers have been trained in basic crash prevention techniques.
3. Large Scale Safety Campaigns have been undertaken to prevent speeding, and rear-end collisions, and promote rear seat belt usage. As of October, 2023, 5 such campaigns have been conducted.
4. Multilingual road safety messages have been developed and are played on loop at the toll plazas.

4.3.5 Emergency Medical Care

1. Three ambulances that operate on the Expressway were upgraded with the latest safety equipment. These ambulances were relocated to optimize their response times (i.e. the time taken between the call for an ambulance and the ambulance arriving at the patient's location).

2. So far, 150 Highway Police and 1,700 other responders (police personnel and volunteers) have been trained in BTLS.

Figure: 4.3 BTLS trainings at MPEW (source: SaveLIFE Foundation)

4.4 TEAM STRUCTURE AND STAKEHOLDERS

The team structure comprised members from MSRDC, Maharashtra Highway Safety Police, State Road Transport Office, and an NGO.

- MSRDC: Vice Chairman and Managing Director, Joint Managing Directors, and Chief Engineer
- Police Department: Additional Director General of Police (Traffic) and Superintendent of Police
- Transport Department: Transport Commissioner, Additional Transport Commissioner, and Regional Transport Offices (RTOs) RTO Officers

4.5 PROJECT FUNDING

The project cost INR 2-2.5 billion (USD 24.3-30.4 million) over a period of 7 Years (MSRDC 2023).

4.6 REPLICABLE PRACTICES

1. **Conducting Forensic Crash Investigations:** The States can institute forensic crash investigations to identify the factors contributing to crashes and injuries to develop clear recommendations to prevent future crashes on the stretch. Similar crash investigations take place on the NH-48. Under Section 135 of the Motor Vehicles Act, 1988, States may make schemes for forensic crash investigation. Therefore, crash investigation, as it is conducted on the MPEW, can be notified by each State.

2. **Strategic Positioning of Enforcement and Emergency Care Resources:** Highway or expressway patrolling vehicles and ambulances can be suitably positioned near black spots and other crash-prone sites. As opposed to evenly distributing patrolling vehicles, police vehicles were deployed at high fatality zones to enable quick action in the event of a crash. This also improved regular patrolling aimed at preventing illegal and unauthorized driving on the expressway. Ambulances were optimized, upgraded, and similarly positioned to provide quick emergency medical care on the expressway. State governments can position medical transport and first response vehicles as per a similar logic to ensure such resources are positioned as per their need. Further, the movement of such vehicles can be tracked using GIS, and the recorded data can guide future procurement, allocations, and improvements in the delivery of emergency services.

4.7 KEY LEARNINGS/LESSONS LEARNED

1. **Prioritization of Safety over Visual Elements:** At the inception of the project in 2016, flower pots were initially present at the median of the expressway to create a prominent barrier between carriageways as well as improve the aesthetics of the expressway. However, these were road safety hazards as the impact of crashes with these flowerpots was high. A serious injury was reported the year before flower pots were removed from the project stretch. Therefore, the flowerpots were later identified as a risk factor, and subsequently removed in 2017 under the ZFC project, and were replaced with median crash barriers. The median crash barriers can absorb energy from crashes, hence reducing the impact of such crashes. Therefore, while visual elements may make the roads more aesthetically pleasing, they should not compromise the safety of road users. Visual elements that hinder safety of road users should be removed from the corridor.

Case Study 5:
ANDHRA PRADESH

Renigunta-Kadapa Stretch (SH-31)

The 138 km Renigunta-Kadapa stretch on the Renigunta-Rayalcheruvu Corridor witnessed a crash severity of 35.7 in 2012, which is higher than the crash severity at the national level i.e. 28.2 in the same year. Interventions across the 4E's were implemented on the stretch, which resulted in a 22% reduction in deaths from 2012-15. The project's implementing agency is the Roads and Buildings Department, Andhra Pradesh.

1 KEY DATES: THE PROJECT WAS APPROVED ON OCTOBER 15, 2009 (WORLD BANK ICR 2019), THE BASELINE SURVEY WAS CONDUCTED ON MARCH 31, 2010, iRAP ASSESSMENT WAS CONDUCTED IN JUNE 2010 (iRAP 2011). THE CORRIDOR WORK BEGAN IN 2014 (WORLD BANK BLOGS 2018). THE PROJECT WAS COMPLETED ON MARCH 31, 2019 (WORLD BANK ICR 2019)

2 AREA COVERED: 138 KM OF THE RENIGUNTA-KADAPA STRETCH ON THE RENIGUNTA-RAYALACHERUVU CORRIDOR

3 IMPACT: REDUCTION IN ROAD CRASH DEATHS: 22% BETWEEN 2012 AND 2015

4 SCOPE OF REPLICATION: THE INTERVENTIONS UNDER THIS PROJECT CAN BE BENEFICIAL FOR HIGH-FATALITY CORRIDORS

Road Crash and Road Crash Death - Renigunta- Kadapa Corridor
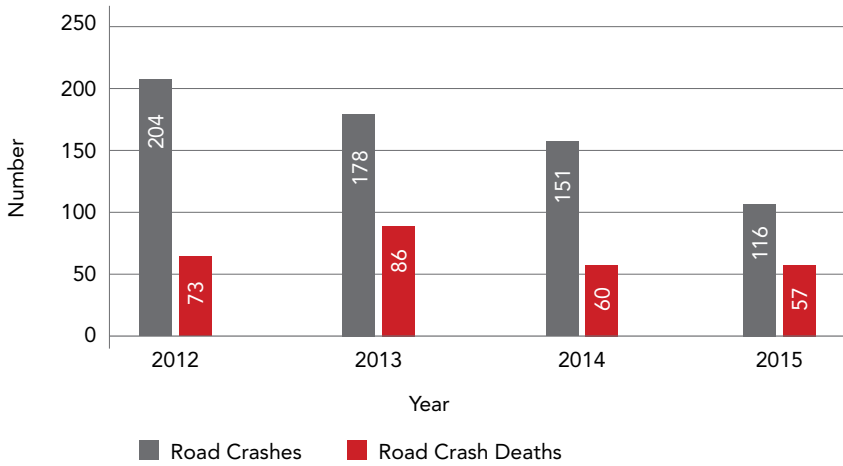
Graph 5.1: Road crash deaths on the Renigunta- Kadapa corridor (2012-2015)
(Source: World Bank presentation shared on 26th April 2023 (World Bank PPT 2023).
Civil works of the project were completed in 2013)

1. Documents Reviewed:
a. Andhra Pradesh Demonstration Corridors Preliminary Technical Report - iRAP 2011
b. RTI Response from Andhra Pradesh Roads and Buildings Department dated 1st June 2023.
c. iRAP India Four States Road Safety Report 2011
d. World Bank presentation (2023)
e. World Bank PAD 2009
f. World Bank ICR 2019
g. World Bank Blogs by Nupur Gupta 2018
h. Report of the Comptroller Auditor General (CAG) on the Economic Sector for the year ended March 2016, (Report No. 4 of 2017)

2. For this case study the exchange rate effective is $1=Rs. 69.55 as on March 31, 2019, as mentioned in the World Bank ICR
   Report 2019

5.1 ABOUT THE PROJECT

The Government of Andhra Pradesh, in partnership with the World Bank Group, developed a Road Safety Demonstration Corridor. The objective of the project was to sustainably provide safe roads to road users by augmenting the capacity of the Andhra Pradesh government's road sector institutions (World Bank ICR 2019). The Roads and Buildings (R&B) Department of Andhra Pradesh had the overall project implementation responsibility. The R&B Department has several units, which have chief engineers as their heads, and one of these units i.e. the Road Development Corporation (RDC) was appointed as the Project Management Unit (PMU) for the project (World Bank PAD 2009).

The government along with the World Bank took up a corridor to test out a new road safety program, a 138 km stretch between Renigunta and Kadapa on the SH-31 was selected, and a multi-sectoral approach across Engineering, Transport, Police, and Emergency Care was deployed (World Bank ICR 2019).

5.2 BACKGROUND

In 2009, the Government of Andhra Pradesh decided that a Road Safety Action Plan needs to be in place for the State. This was because the State witnessed a high number of road crashes, the number being 42,106 resulting in 14,516 deaths in 2009 alone (MoRTH 2009). As part of the plan, it identified a larger 259-km-long Renigunta-Rayalacheruvu Road (SH31) as one of the three demonstration corridors requiring urgent safety improvements, as despite representing less than 1% of the total State Highways in Andhra Pradesh, these roads accounted for approximately 4% of the State's road crash deaths (iRAP 2011). An iRAP assessment was undertaken to analyze the current standards of the road for different road users (car occupants, motorcyclists, bicyclists, and pedestrians). iRAP had inspected and assigned ratings to the corridor with a focus on 50 road attributes relating to the likelihood of a crash and its severity by using software, vehicles

Decision-Making Tools:
iRAP assessment of the quality of the road

Enabler:
The Government Order G.O. Rt. No. 167, Dated 19th February, 2011, Roads and Buildings Department

Validation Mechanism:
Analysis of road crash data

	CAR OCCUPANTS		MOTORCYCLISTS		BICYCLISTS		PEDESTRIANS	
Star Rating	Length (km's)	%	Length (km's)	%	Length (km's)	%	Length (km's)	%
★ ★ ★ ★ ★	0km	0%	0km	0%	0km	0%	0km	0%
★ ★ ★ ★	14km	5%	5km	2%	0km	0%	0km	0%
★ ★ ★	18km	7%	10km	4%	0km	0%	0km	0%
★ ★	166km	64%	112km	43%	98km	38%	176km	68%
★	62km	24%	132km	51%	0km	0%	0km	0%
	0km	0%	0km	0%	161km	62%	83km	32%
TOTAL	259km	100%	259km	100%	259km	100%	259km	100%

Figure 5.1. Baseline iRAP star ratings for various categories of road users on the corridor (Source: iRAP "AP" 2011)

that were specially equipped for the inspection, and trained analysts. Some of these attributes were intersection design, road cross-section and markings, roadside hazards, footpaths, and bicycle lanes (iRAP 2011). The results of the assessment have been given above.

The iRAP assessment indicated that the stretch required urgent interventions to augment its safety (iRAP 2011). In addition to iRAP, the Andhra Pradesh Transport Department also took a closer look at the available data to get an understanding of the major risk factors contributing to road crashes on the stretch. The following observations were made:
- Numerous collisions involving trucks occurred because of fatigued drivers.
- Drivers were caught speeding to reach Tirupati, a holy town in Andhra Pradesh, to attend the early morning ceremonies (World Bank Blogs 2018).

Post these assessments, a 138 km stretch from Renigunta to Kadapa was selected as the project stretch for the Road Safety Demonstration Corridor.

5.3 INTERVENTIONS

Based on the data from the World Bank Group and the Andhra Pradesh State Government, the following interventions were implemented across the 4 E's of road safety (i.e. Engineering, Enforcement, Education, and Emergency Care):

5.3.1 Engineering

Some of the Civil Work conducted by the Andhra Pradesh Road Development Corporation on the most vulnerable parts of the stretch involved interventions such as:

1. Improvements of intersections and curves (World Bank Blogs 2018) - out of the 13 proposed locations, 8 locations were improved. 5 locations could not be taken up due to objections from the State Railway Department, and due to the non-availability of "Right of Way." (APRDC 2023).
2. The widening of the road carriageways and curves, installation of retro-reflective signages, addition of lane markings, and safe pedestrian crossings (World Bank Blogs 2018).
3. Installation of crash barriers, and road studs (World Bank Blogs 2018).
4. Blackspot improvements on core road networks (World Bank ICR 2019).

There was a 53% reduction in crashes and a 42% reduction in deaths due to civil work on dangerous curves and intersections (World Bank Blogs 2018).

5.3.2 Enforcement Measures

1. Two Highway Patrolling Outposts were created at Rajampet and Renigunta (World Bank Blogs 2018). They were equipped with tow-away cranes, patrolling vehicles, speed laser guns, and breath analyzers, among other such safety equipment.
2. The focus of enforcement was on checking for over-speeding and driving under the influence of alcohol. Thus, there was a resultant reduction in road crashes involving cars, auto-rickshaws, and Light Commercial Vehicles (LMVs) (World Bank Blogs 2018).

Figure 5.2. Interceptor vehicle procured to patrol the corridor (Source: World Bank)

5.3.3 Education/Engagement

1. All stakeholders received refresher training in road safety measures through workshops for the smooth implementation of the project (The Hindu 2016).
2. Driver Refresher training was conducted for 250 school bus drivers and 300 truck drivers at Kadapa (APRDC 2018).

5.3.4 Emergency Medical Care

A trauma care center was established at Rajampet along with required medical equipment including CT scan equipment, and ambulances (CAG 2017).

5.4 TEAM STRUCTURE AND STAKEHOLDERS

The stakeholders involved in this project are the Roads and Buildings, Police, Transport, and Medical and Health Departments of Andhra Pradesh (World Bank ICR 2019).

5.5 PROJECT FUNDING

Government of Andhra Pradesh reported funding:

The Govt. of Andhra Pradesh reportedly allocated approximately INR 349 million (USD 5 million) (RTI Response, R&B Department 2023).

World Bank Reported Funding:

The road safety component project cost around INR 834.6 million (USD 12 million) (World Bank ICR 2019). Additionally, the institutional strengthening cost around approx. INR 668 million (USD 9.6 million). The institutional strengthening component provided technical assistance, advice, and training to improve the operations of the Andhra Pradesh Road Development Corporation (APRDC), and management of public-private partnership projects as well as management of the core road network project. The Institutional Strengthening Action Plan Governance and Accountability Action Plan were also introduced under this payment head (World Bank ICR 2019).

5.6 REPLICABLE PRACTICES

1. **Highway Patrolling Outposts and Patrolling Vehicles:** The Highway Patrolling Outposts set up in Rajampet and Renigunta and the interceptor vehicles pacing the corridor were key in checking for speeding, overloading, and drunk driving violations. The vehicles were equipped with roof-light sirens and GPS, and enforcement personnel were at the ready with tow-away cranes, breathalyzers, searchlights, and speed laser guns. States can provide highway patrol teams on crash-prone stretches with equipment suitable to detect the most frequent violations on the stretch. The standards for such equipment, whether electronic or otherwise, can be notified by the Supreme Court Committee on Road Safety for the States' reference.

2. **Monthly Reviews on Road Safety:** The road safety situation on project roads can be monitored and improved by ensuring tight accountability such as via periodic reporting to top members of the State administration. The Transport minister of Andhra Pradesh had directed the district administration involving the District Collector, Superintendent of Police, and Transport Department officials to conduct regular monthly reviews. The case studies developed on the crashes were shared directly with the State Chief Minister every month. Reporting to important government offices in key road safety projects can improve the accountability, efficiency, and transparency of departments implementing the project at the ground level. Such methods of monitoring the implementation at the grassroots by senior government officials have also been adopted in States such as Tamil Nadu, where senior officials are members of road safety agencies.

Case Study 6:
TELANGANA

Hyderabad Bijapur Corridor (SH-04)

The 118 km stretch on the Hyderabad-Bijapur Corridor witnessed a crash severity of 58.7 in 2014 which was higher than the national average i.e. 28.5 for the same year. Interventions across the 4E's were implemented on the stretch, which resulted in a 38.1% reduction in deaths from 2014-18. The project was implemented by the Roads and Buildings Department, Telangana.

1 | **KEY DATES: THE PROJECT WAS APPROVED ON 22ND JANUARY 2010 (ROADS AND BUILDINGS DEPARTMENT 2011). THE PROJECT COMMENCED ON 30TH JUNE 2015 (WORLD BANK ICR 2019). THE PROJECT ENDED ON 31ST MARCH 2019, HOWEVER, IMPACT NUMBERS ARE AVAILABLE ONLY TILL 31ST DECEMBER 2018 (WORLD BANK ICR 2019)**

3 | **IMPACT: REDUCTION IN ROAD CRASH DEATHS: 38.1% BETWEEN 2014 AND 2018**

4 | **SCOPE OF REPLICATION: THE INTERVENTIONS UNDER THIS PROJECT WILL BE BENEFICIAL ON CORRIDORS WHERE THE CRASH SEVERITY IS HIGH**

2 | **AREA COVERED: 118 KM STRETCH ON THE HYDERABAD-BIJAPUR CORRIDOR**

Road Crash and Road Crash Deaths: Hyderabad- Bijapur Corridor
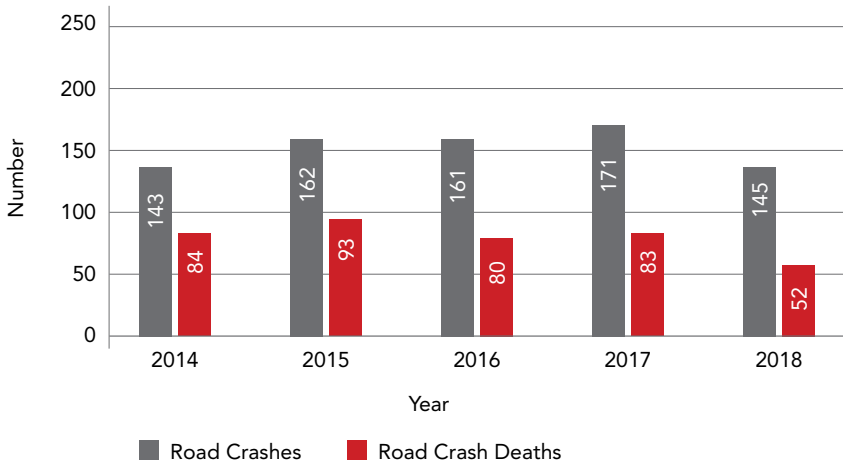
Graph 6.1: Road crashes and deaths on the Hyderabad- Bijapur corridor
vs Year (2014-2018)
(Source: Roads and Buildings Department, Telangana)

1. Documents Reviewed:
a. Questionnaire answered by Mr. P. Ravinder Rao, the Engineer-in-Chief (R&B), State Roads
b. World Bank ICR 2019
c. Roads and Buildings Department's Note on Telangana Road Sector Project, 2019.
d. Roads and Buildings Department's Government Order "A-GO 28 DT- 18.2.2011", 2011.

2. For this case study, the exchange rate effective is $1=Rs. 69.55 as on March 31, 2019, as mentioned in the World Bank ICR
   Report 2019.

6.1 ABOUT THE PROJECT

By delivering higher-quality and safer roads to all users, the Roads and Buildings Department (R&B) hoped to sustainably improve the State road network (Roads and Buildings Department 2022). The Roads and Buildings Department of the Government of Telangana, in collaboration with the World Bank Group, constructed a Road Safety Demonstration Corridor to make Telangana's roads safer.

To test and implement a new road safety program that included contributions from several industries, the government chose one corridor. The program's chosen section was the Hyderabad-Bijapur corridor (State Highway-4) (Roads and Buildings Department 2022). The 118-kilometer-long Hyderabad-Bijapur Corridor runs through the districts of Rangareddy and Vikarabad. It extends from the APPA Junction (kilometer 14/0), where it intersects the Outer Ring Road to kilometer 132/269, i.e. up to the Karnataka border. The route travels through several mandals, villages, and electoral districts, including Moinabad, Chevella, Manneguda, and Parigi (World Bank ICR 2019).

6.2 BACKGROUND

Based on the data received by the Telangana Roads and Buildings department, in 2014, before the Hyderabad-Bijapur Corridor was adopted as a Road Safety Demonstration Corridor, the stretch witnessed 143 crashes and 84 deaths. This indicated that there was a requirement for urgent intervention to augment road safety on the stretch. In an attempt to adopt a convergent approach by stakeholder departments as opposed to a divergent approach towards road safety, the establishment of the Road Safety Demonstration Corridor project was the need of the hour (Roads and Buildings Department 2022).

Decision-Making Tools:
FIR Data

Enabler:
The Government Order G.O. Ms. No. 28, Dated 18th February, 2011 Roads and Buildings Department

Validation Mechanism:
Impact assessment was done using data collected from Police Stations along the corridor (Roads and Buildings Department 2022)

6.3 INTERVENTIONS

In order to obtain more details on the implementation of the good practices across the 4 E's of road safety (i.e. Engineering, Enforcement, Education, and Emergency Care), a questionnaire was sent to the Roads & Buildings Department, Government of Telangana. The response was shared by Mr. P. Ravinder Rao, the Engineer-in-Chief (R&B), State Roads.

6.3.1 Engineering

The engineering interventions implemented by the R&B Department included:

1. Output and Performance-based Road Contracts of a duration of five years each were implemented for the corridor. The contract terms were such that the maintenance of the roads was reported to be very good (World Bank ICR 2019).
2. Widening of curves: 20 curves were improved and 1 curve was widened on the corridor.
3. Three intersections along the corridor were improved.
4. To improve the intersections and curves of the project stretch, measures such as widening of the road, tree translocation, and road furniture upgradation were taken up by the R&B Department.
   a. 126 trees were translocated.
   b. Road furniture was upgraded.
   c. Street lighting was installed at intersections (Roads and Buildings Department 2022).
5. Mobile barriers and fluorescent cones were also installed (World Bank ICR 2019).

A separate pre- and post-implementation assessment of the impact of the engineering interventions alone on road crash indicators revealed that even though the number of crashes initially increased, the deaths reduced:

Table 6.1: Crash Severity And Deaths Per Kilometer Before and After Civil Works on the Corridor		
Indicator	Before Completion of Civil Works	After Completion of Civil Works
Severity (Average)	58	45
deaths per km (Average)	0.74	0.6

(Source: Roads and Buildings Department 2022)

6.3.2 Enforcement Measures

The enforcement interventions were implemented by the Police Department. These included:

1. Highway outposts at Manneguda and Kodangal to help in better management of road traffic.
2. Patrolling and interceptor vehicles for the project, which were equipped with:
   a. Laser speed guns
   b. Fluorescent cones
   c. Body-worn cameras
   d. Video still camera (Digital)
   e. Fluorescent-painted jackets and helmets for the personnel's safety
   f. Mobile barriers
3. Breathalyzers with printers to ensure a check on cases of drink-driving (World Bank ICR 2019).
4. Overloading was identified as one of the leading causes of road crashes, involving trucks(Roads and Buildings Department 2019). To check the overloading violations, 2 electronic weighbridges were installed on the corridor (Roads and Buildings Department 2022).

6.3.3 Education/Engagement

1. Awareness programs were conducted at schools, and school children have shown a reported improvement in behavior with respect to following road safety precautions while using the roads. This led to a reduction in crash occurrences in school zones (Roads and Buildings Department 2019).

2. The "No Helmet-No Petrol" campaign in Alidabad, Telangana was launched on 2nd June, 2016. Each Mandal in the district was allocated to two Assistant Motor Vehicles Inspectors, who were responsible for the implementation of the campaign under Motor Vehicles Inspector's supervision. The campaign results were inconclusive as the data analyzed was limited, in that it did not provide data specific to the second half of 2016, i.e. post the launch of the campaign.

6.3.4 Emergency Medical Care

1. A fully equipped Level-III Trauma Care Center was established at Tandur. Further, the existing ground floor building of the Women and Children's Hospital Block of District Hospital, Tandur was converted to accommodate a Trauma Care Center. Construction works of the Trauma Care Center (TCC) were completed under the project. Further, 35 medical equipment were procured and delivered to TCC (Roads and Buildings Department 2019).

2. An ambulance was also procured under the project (World Bank ICR 2019). Further, the operation of ambulances and connectivity to the nearest Trauma care center were strengthened (Roads and Buildings Department 2022).
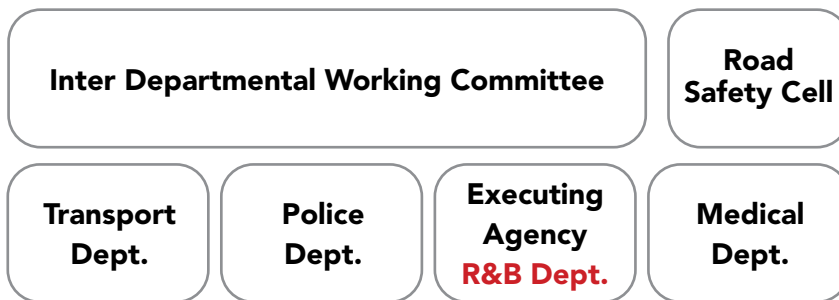
Figure 6.1: Departments involved in the project (Source: Questionnaire reply of the Engineer-in-chief, R&B Department)

6.4 TEAM STRUCTURE AND STAKEHOLDERS

For this project, the R&B Department, Police Department, Transport Department, and Health Department of Telangana worked in collaboration to implement various project elements.

An Empowered Committee (EC), headed by the Principal Secretary, Transport Department and consisting of officials from the Transport Department, Police, Medical and Health and R&B department was responsible for the permissions and reviewing the project progress (Roads and Buildings Department 2022).

6.5 PROJECT FUNDING

The project has been jointly funded by the State Government and World Bank. The total amount of implementation was INR 297.9 million (USD 4.3 million). This total funding included measures deployed under the four main road safety pillars viz. road engineering, police enforcement, emergency medical care, and road safety education and awareness (Roads and Buildings Department 2022).

6.6 REPLICABLE PRACTICES

1. **Creation of trauma care centers (TCCs) within existing facilities:** Repurposing of medical facilities, including the provision of ambulances and fresh equipment, can drastically improve regional emergency medical care capacity. Management of the Golden Hour is considerably improved if hospitals nearby can adequately handle trauma cases. This likely contributed to reducing road crash deaths observed on the Hyderabad-Bijapur corridor. Similar to how the Women and Children's Hospital Block of District Hospital in Tandur was provided with a new Level-III trauma care center, the capacity of existing hospitals near other crash-prone areas can be upgraded. The State can identify existing facilities amenable to upgradation and create a blueprint for upgrading them to be able to tend to road crash victims.

2. **Framing Output and Performance-based Road Contracts (OPRC):** These contracts hold the contractors responsible for the road design, construction, and maintenance standards. The payment is dependent on the output of the contractor, and packages are awarded at different stages of progress in the project. For the Hyderabad-Bijapur corridor, it was reported that road maintenance had improved post such contracts. Such output-based contracts will ensure that contractors are incentivized to maintain the roads according to relevant standards.

3. **Undertaking complementary enforcement and engineering activities:** The project saw the improvement of curves and intersections and the provision of cones and barriers at spots where the road geometry guided the traffic towards unsafe interactions. This was complemented by focused enforcement activity such as deploying weighbridges to check overloading violations and using breathalyzers and cameras (both body-worn and digital cameras) to discourage drunk driving and speeding. Two highway police outposts at Manneguda and Kodangal ensured vigilant oversight.

6.7 KEY LEARNINGS/LESSONS LEARNED

1. **Authorization of procurement by agencies with the relevant expertise:** The responsibility for procurement of all equipment was with the R&B Department. This includes the procurement of ambulances and medical equipment as well as equipment required by the police for enforcement (eg. Breathalyzers, and speed guns to name a few). Thus, there was a lack of expertise in the procurement process (Roads and Buildings Department 2022). The R&B Department then identified that the procurement process should be suitably divided amongst the departments that can best understand their requirements and the operations of the procured equipment. This should be kept in mind for any future road safety projects, where only departments with adequate expertise should be authorized to procure materials for road safety works.

Case Study 7:
UTTAR PRADESH

Yamuna Expressway (YEW)

The 165.5 km stretch on the Yamuna Expressway witnessed 105 deaths per 100 kilometers in 2019, which is higher than the national average of deaths on national highways i.e. about 40 deaths per 100 km in the same year. Interventions across the 4E's were implemented on the stretch, which resulted in a 37.71% reduction in deaths from 2019-2022. The project's implementing agency is the Yamuna Expressway Industrial Development Authority (YEIDA).

1 KEY DATES: THE PROJECT WAS APPROVED ON 11TH JANUARY 2020, AND IS ON-GOING

3 IMPACT: REDUCTION IN ROAD CRASH DEATHS: 37.7% BETWEEN 2019 AND 2022

2 AREA COVERED: 165.5 KM STRETCH IN THE YEW

4 SCOPE OF REPLICATION: THE PROJECT CAN BE IMPLEMENTED ON ACCESS-CONTROLLED EXPRESSWAYS OR HIGHWAYS.

Road Crash and Road Crash Deaths - Yamuna Expressway
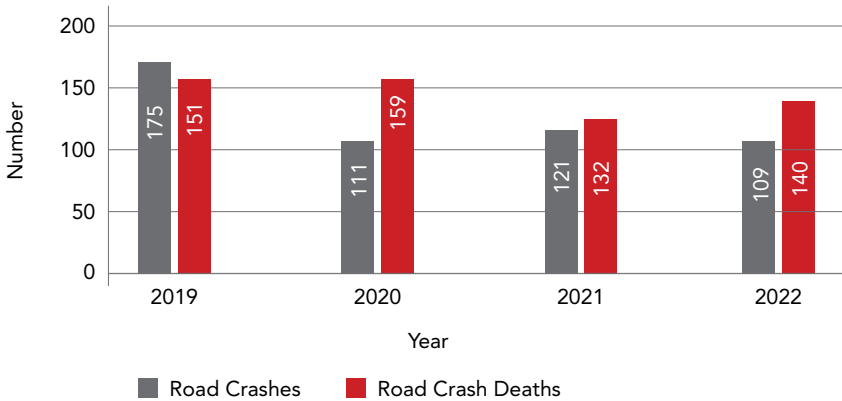
Graph 7.1: Road crashes and deaths on the YEW vs Year(2019-2022)
(Source: Uttar Pradesh Transport Department 2023)

7.1 ABOUT THE PROJECT

The 165.5-km-long Yamuna Expressway (YEW) is situated in the districts of Gautam Budh Nagar, Bulandshahar, Aligarh, Mahamaya Nagar (Hathras), Mathura and Agra in the State of Uttar Pradesh ("Yamuna Expressway Project – YEIDA" 2023). The six-lane access-controlled expressway was inaugurated in 2012 and is managed by the Yamuna Expressway Industrial Development Authority (YEIDA) and the Government of Uttar Pradesh (YEIDA 2021). The expressway has a speed limit of 100 km/h for LMVs and 80 km/h for HMVs (Hindustan Times 2022).

7.2 BACKGROUND

Over time, the YEW became one of the deadliest roads in the country. As per government data, from 2013 to 2019, the stretch registered approximately 5,400 crashes and 950 deaths. This translates to about 32 crashes and 5 deaths per kilometer of the expressway (UP Transport Department 2019). The high volume of road crash deaths on the expressway highlighted the necessity for immediate intervention. On 11th January 2020, the Uttar Pradesh

1. Documents Reviewed:
i. Questionnaire answered by Mr. Pushp Sen Satyarthi the Additional Transport Commissioner (Road Safety), Uttar Pradesh

2. For this case study, the average exchange rate for 2023 (until July 2023), where $1=Rs. 82.2 has been considered

Transport Department signed a Memorandum of Understanding with an NGO to transform the 165.5 km long expressway into a Zero Fatality Corridor (ZFC).

The Transport Department has been working across the 4E's of road safety which include Engineering, Enforcement, Emergency Care, and Education to reduce the deaths on the selected stretch. A Safety Survey was conducted in 2020 for the Yamuna Expressway to highlight the road safety deficiencies on the stretch. Further, data analysis to identify the crash risk factors, injury risk factors, and hazardous locations, to name a few, was conducted. The data analyzed included FIR data, crash data, black spot data, and overspeeding data to name a few. The data analysis revealed important information related to the location, time, and type of deaths occurring on the YEW (Transport Department 2023).

To obtain further details on the implementation of the good practices employed across the 4 E's of road safety (i.e. Engineering, Enforcement, Education, and Emergency Care), a questionnaire was sent to the Transport Department, Government of Uttar Pradesh. Mr. Pushp Sen Satyarthi, the Additional Transport Commissioner (Road Safety and Enforcement), sent his response to the questionnaire.

7.3 INTERVENTIONS

7.3.1 Data Analysis

a. Safety Survey To Assess the Situation On-Ground (Transport Department 2023):

1. The first step undertaken towards deployment of the ZFC project was surveying to analyze the causes of crashes and deaths occurring on this stretch, as well as other risk factors. The Survey was conducted from 10th - 19th August 2020. To identify the various safety issues related to specific locations, the survey team conducted a detailed road safety survey of

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Decision-Making Tools:
Forensic Crash Investigations, Surveys on ground, Crash Data Analysis and Data Analytics

Enabler:
An MoU was signed between the Transport Department, Government of Uttar Pradesh and an NGO focused on Road Safety on 11th January 2020

Validation mechanism:
The primary data was mainly the FIRs maintained by UP Traffic Police. The impact was measured by comparing the road crash fatality data provided by the state traffic police during the period between January 2019 to December 2022 (Transport Department 2023).

Figure 7.1: Safety Survey, SaveLIFE Foundation

the entire stretch. Subsequently, suitable mitigation measures were suggested to enhance the road safety of the YEW.

2. The survey intended to list all critical locations with safety deficiencies to subsequently provide appropriate recommendations and identify locations with probable hazards for further investigations.

3. The survey revealed a total of 1,067 critical engineering risk factors. For example, it found that crash barriers were present along the left side of both carriageways. However, they were absent along the median.

4. Other critical engineering issues detected on the YEW include exposed concrete structures, unsafe pedestrian crossings, absent traffic impact attenuators, absent or damaged rumble strips, absent or damaged chevron markings, and absent road signages, to name a few.

b. Survey Of Enforcement Measures:

1. The survey, which was intended to identify enforcement-related issues that affected YEW commuters, helped list out the safety issues that could potentially be mitigated by enforcement agencies.

2. The survey was conducted through an observational study on the YEW between 9th to 27th November 2020.

3. Several violations were observed including illegal parking of vehicles, wrong-side driving, wrong lane usage, non-usage of safety devices such as helmets and seatbelts, illegal entry into the expressway, and illegal stopping, to name a few.

Figure 7.2: Survey observed improperly parked vehicles on the expressway (Source: YEIDA)

4. The survey also included an analysis of the existing enforcement measures in 2020, before the project's inception. The two organizations responsible for enforcement of the YEW are
    i.   The concessionaire (Jaypee), and
    ii. The traffic police.
    The survey included an analysis of the measures and equipment deployed by both these agencies (Transport Department 2023).

5. Based on the findings of the survey, recommendations were made to monitor each violation.
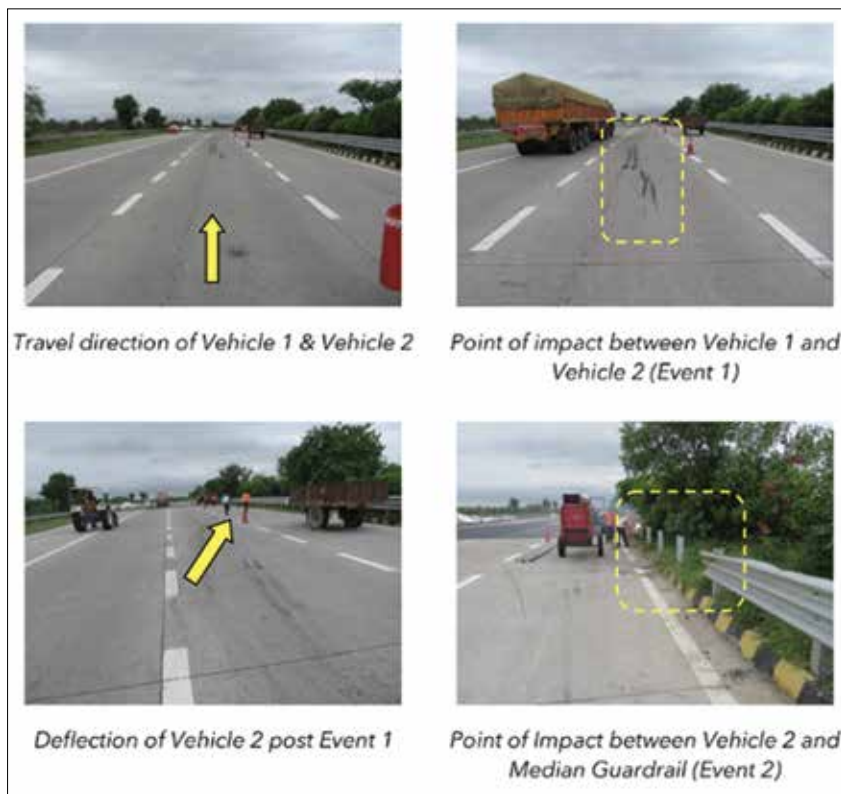

Figure 7.3 Snapshots from a crash investigation conducted on the YEW (Source: SLF's crash investigation report)

c. Forensic Crash Investigation

Further, as a part of the NGO partner's ongoing assessment, 96 Forensic Crash Investigations have been conducted by the NGO on the YEW since 2020. These investigations, conducted under direction from the Uttar Pradesh Transport Department aim to highlight the road safety deficiencies on the stretch that may be addressed on a rolling basis. Forensic Crash Investigation is a technique that helps identify the various causes leading to crashes–for fatal crashes, particularly mass fatality crashes. Through these investigations emerge CCFs and ICFs (Transport Department 2023).

On May 24, 2023, a letter was sent by the Additional Transport Commissioner to the Deputy Secretary of the Uttar Pradesh Transport Department notifying the latter of the introduction of the Uttar Pradesh Crash Investigation Scheme under Section 135 of the Motor Vehicles Act, 1988. On October 12, 2023, the scheme was notified through notification No. - 117/2023/2849/30-3-2023. The institutionalization of crash investigation schemes will set standards to ensure efficient crash investigation.

7.3.2 Engineering
1. Installation of signboards by the concessionaire (i.e. Jaypee) as per the recommendations of the road safety NGO.
2. Installation of a median crash barrier by the concessionaire based on the findings of the Safety Survey.
3. Treatment of exposed hard structures to prevent high-impact crashes.
4. Proper end treatment and transitioning of crash barriers by the concessionaire as per the NGO's recommendations.
5. Installation of road delineators to improve visibility.
6. Provision of retro-reflective Pavement Marking to improve visibility (Transport Department 2023).

7.3.3 Enforcement Measures
1. Capacity building of enforcement on the ground.
2. Installation of additional speed cameras to capture and penalize speeding violations.

3. Enhanced police enforcement on the stretch since 2020 to stop violations (Transport Department 2023).

4. Lower speed limits during winters i.e. from 100 km/hr to 80 km/hr for LMVs and from 80 km/h to 60 km/h for HMVs between December 15, 2022 to February 15, 2023 (Correspondent, HT 2022).

7.3.4 Education/Engagement

Anticipatory Driving and Accident Prevention Training (ADAPT) Training - 169 commercial drivers including HMV and fleet drivers (Uttar Pradesh Transport Department) have been trained in crash prevention and anticipatory driving techniques (Transport Department 2023).

7.3.5 Emergency Medical Care

1. A smart ambulance deployment tool was leveraged on the expressway that analyzes total call volumes and ambulance response times to optimize ambulance deployment plans. The tool analyzed the call volumes from specific locations. The weekly reports gave an aggregate of the daily reports and helped in optimizing the deployment of ambulances in various locations of the expressway for the subsequent week. In other words, high call volumes for a particular location were indicative of a higher incidence of road crashes there. With the help of this information, ambulances were deployed in a manner that facilitated their capacity to reach the road crash victims at the location at the very earliest.

2. The project's NGO partner also conducted training in BTLS techniques for 162 police personnel and volunteers (Uttar Pradesh Transport Department) in Noida and Agra (cities near the expressway). BTLS provides potential bystanders with basic first aid, Cardiopulmonary Resuscitation (CPR), and bleeding control techniques to stabilize road crash victims before they are taken to the hospital. This significantly increases the chances of survival of the victim (Law Commission of India 2006) (Transport Department 2023).

7.4 TEAM STRUCTURE AND STAKEHOLDERS

As per the Uttar Pradesh Transport Department, the following stakeholders contributed significantly to reducing road crashes and deaths on YEW:

1. Transport Department (Government of Uttar Pradesh)
2. Traffic Police (Government of Uttar Pradesh)
3. Health Department (Government of Uttar Pradesh)
4. Concessionaire on the YEW (Jaypee)
5. SaveLIFE Foundation (Non-Government Organization)
6. Yamuna Expressway Industrial Development Authority (YEIDA)

The project stakeholders meet every quarter (since 2020) to assess the progress of the project. These meetings are led either by the Principal Secretary (Transport), or the Transport Commissioner of Uttar Pradesh.

7.5 PROJECT FUNDING

*   The Yamuna Expressway was developed by the Jaypee Group under a Public-Private Partnership. The total project cost is approximately INR 130 billion (USD 1.6 billion). The concession period is 36 years. This total funding included measures deployed under the four main road safety pillars viz. road engineering, police enforcement, emergency medical care, and road safety education and awareness.

7.6 REPLICABLE PRACTICES

1. **Utilization of Ambulance Deployment tool:** The ambulance deployment tool can be scaled to multiple stretches of roads to gain valuable insights via data analytics of locations with a high number of trauma cases. The tool is a low-cost intervention and can cover all trauma and emergency cases, including road crashes. It can be operated either by the emergency response centers of all State ambulance services (eg. 102 ambulances, 112 ambulances) or contracted to a private party.

2. **Informing Interventions through Audits across 4 E's:** The prevailing audit mechanisms in India currently involve an assessment of only engineering risk factors. However, the Enforcement Survey conducted under this project is an evidence-generation tool specific to only enforcement issues. To increase the scope of risk factor assessment, audits and surveys should cover all 4 E's of road safety. The enforcement survey can be used as a reference for assessing enforcement issues on stretches across India. Similar audits are done as part of CVAs in MPEW and NH-48.

3. **Trainings to Instill Behavior Change:** The authorities identified that instilling a change in road user behavior is paramount towards preventing road crashes caused due to human errors such as overspeeding and non-usage of safety devices. As many of the crashes took place due to human behavior on the YEW, and it faces high incidences of road traffic violations, awareness generation was a necessary aspect added to the project. Thus, along with enforcement, measures to augment awareness among road users are essential to improve adherence to road safety norms. Hence, the authorities are conducting training programs for anticipatory driving and crash prevention techniques.

7.7 KEY LEARNINGS/LESSONS LEARNED

1. **Adoption of Capacity Building and Electronic Enforcement measures**: The State Transport Department stated that while they had the interventions chalked out that needed to be implemented on the ground level, they were faced with a dearth of enforcement officials necessary to do the same. To make interventions robust and capable of making the YEW safer, it is of paramount importance that adequate number of traffic enforcement personnel are engaged on this stretch. The department is actively working towards building its capacity through electronic enforcement measures.

Case Study 8:
GUJARAT

Bharuch-Dehgam Corridor
Gandhinagar-Koba-Indira Bridge
Mehsana - Himatnagar Highway

In Gujarat, three corridors were selected for interventions. The 11.3 km Bharuch-Dehgam Corridor, 11.5 km Gandhinagar-Koba-Indira Bridge, and the 66 km Mehsana Himatnagar Corridor witnessed interventions across the 4 Es to improve the road safety scenario. The project resulted in a reported improvement in the safety standards of the stretches. The Gujarat Roads and Buildings Department was the implementing agency.

1 | **BHARUCH-DEHGAM CORRIDOR (SH-6):**
- KEY DATES: THE PROJECT WAS APPROVED IN 2013. IT COMMENCED IN 2014 AND WAS COMPLETED AT THE END OF 2021 (WORLD BANK ICR 2021)
- AREA COVERED: 11.3 KM STRETCH
- SCOPE OF REPLICATION: CAN BE IMPLEMENTED ON SHORT STRETCHES THAT WITNESS HIGH SPEEDS. THESE COULD BE HIGH FATALITY ZONES ON A ROAD SUCH AS A HIGHWAY.

2 | **GANDHINAGAR-KOBA-INDIRA BRIDGE:**
- KEY DATES: THE PROJECT WAS APPROVED IN JANUARY 2017. IT COMMENCED IN SEPTEMBER 2018 AND WAS COMPLETED AT THE END OF 2021 (WORLD BANK ICR 2021)
- AREA COVERED: 11.5 KM STRETCH
- SCOPE OF REPLICATION: CAN BE IMPLEMENTED ON BRIDGES OF SIMILAR LENGTH.

3 | **MEHSANA - HIMATNAGAR HIGHWAY**
- KEY DATES: THE PROJECT COMMENCED IN FEBRUARY 2017 (IRAP 2019) AND WAS COMPLETED IN AUGUST 2018 (INDIARAP 2020)
- AREA COVERED: 66 KM STRETCH
- SCOPE OF REPLICATION: THE PROJECT CAN BE IMPLEMENTED ON HIGH-SPEED HIGHWAYS.

8.1 ABOUT THE PROJECT:

The Roads and Buildings Department, Government of Gujarat in partnership with the World Bank considered developing safe corridors with multi-dimensional road safety interventions. The project has a target of achieving a minimum 3-star rating (iRAP Assessment) (World Bank ICR 2021).

- The Bharuch - Dehgam is the pilot safety demonstration project with a road length of 11.3 km (World Bank ICR 2021).

- The second corridor selected for the demonstration of road safety intervention, the Gandhinagar - Koba - Indira Bridge with a total length of 11.5 km, was taken up to ensure safety and free flow of traffic (World Bank ICR 2021).

- The third corridor selected, the Mehsana-Himatnagar stretch starting from Mehsana has a road length of 66 km. The corridor passes through Mehsana, Visnagar, Vijapur, Manasa, and Himatnagar taluka of Mehsana, Gandhinagar, and Sabarkantha Districts. The corridor comes under the protected forest region therefore forest clearance for land diversion for non-forest use was required (MoEF 2013).

1. Documents Reviewed:
   Bharuch-Dehgam Corridor
a. World Bank PAD 2013
b. World Bank ICR Report 2021
c. Roads and Buildings Department's GSHP II - LEADS Newsletter 2020

2. Documents Reviewed:
   Gandhinagar-Koba-Indira Bridge:
a. World Bank ICR Report 2021
b. Roads and Buildings Department's GSHP II - LEADS Newsletter 2020

3. Documents Reviewed:
   Mehsana - Himatnagar Highway
a. IndiaRAP's Case studies of implementation: Saving
   lives through safer roads Report 2020
b. Post Construction iRAP Assessment, India
   (Mehsana – HIMATNAGAR SH-55, Gujarat), 2019
c. Roads and Buildings Department's GSHP II - LEADS Newsletter 2020
For this case study the exchange rate effective
is $1 = Rs. 73.22 as on December 21, 2020, as mentioned in the World Bank ICR Report 2021

Box 8.1. Mehsana Himatnagar Highway post-construction assessment

A post-construction assessment of the Mehsana-Himatnagar highway segment was completed in April 2019, and for all road users—aside from pedestrians—there was a significant improvement in the length of the route. However, the installation of pathways, pedestrian fences, crossing facilities at crossroads, and traffic calming measures resulted in a dramatic improvement in pedestrian safety in metropolitan areas where there was a high volume of pedestrian traffic (IndiaRAP 2020).

BEFORE INTERVENTIONS

AFTER INTERVENTIONS

Figure 8.1: iRAP assessment on the stretch (Source: IndiaRAP 2019, SH-55)

Note: the black stretches have an iRAP rating of 1; the red stretches have an iRAP rating of 2, the orange stretches have an iRAP rating of 3, the yellow stretches have an iRAP rating of 4.

Box 8.2. Gujarat Road Safety Authority (GujROSA)

Gujarat is the second State to establish a State Road Safety Authority, after Kerala, which established its Road Safety Authority in 2007 (The Times of India 2021). GujROSA was established in December 2020, almost three years after the Gujarat Road Safety Authority (GujROSA) Act, 2018 came into force (Government of Gujarat 2018) to constitute a road safety authority responsible for the implementation of road safety programs in the State. The GujROSA was established with the help of the World Bank, where WB assessed the State's road safety management capacity at the institutional level, and checked whether the State had a strategy to address road safety.

To augment road safety management in the State of Gujarat, in 2010, the World Bank worked towards establishing a steering committee as part of the Second Gujarat State Highway Project (GSHP-II), which further evolved into the State road safety authority (World Bank Blogs 2019). A fully

Figure 8.2a: Training of police by GujROSA

resourced Road Safety Steering committee was established in April 2012 to lead and manage the design and overall monitoring of road safety management in the State. This was supported by a Working Group (formed in May 2012) with members from the Transport, Police, Roads and Buildings, Health and Education departments, and the National Highways Authority of India (NHAI). Since the inception of the Steering Committee in 2012, the number of road crashes decreased by 39% and the number of deaths decreased by 5.5% between 2012 (MoRTH, 2013) and 2019 (MoRTH, 2020). Thus, the Steering Committee evolved into a statutory organization i.e. Gujarat Road Safety Authority.

GujROSA is in charge of the following:

- Working as a Lead Agency in coordination with departments such as the Commissionerate of Transport, Home Department, Roads and Buildings Department, National Highway Authority of India, Health Department, Urban Development Department, and Department of Education (GRSA "Introduction" 2023)
- Prescribing and enforcing road safety standards and procedures across the State
- Supervising the implementation of all road safety laws in the State
- Holding public officials, public or private entities or institutions accountable for non-compliance with its orders (World Bank Blogs 2019).

Figure 8.2b: Training of National Service Scheme youth volunteers by GujROSA.

Stakeholders: The members of GujROSA are State Transport Minister (Chairperson), Secretary Transport (Head of Executive Committee), Road Safety Commissioner (Chief Executive Officer), Secretary, Ports and Transport Department, Secretary, Roads and Buildings Department, Secretary, Home Department, Director General of Police, Administrative Manager, GSRTC, Municipal Commissioner, Ahmedabad Municipal Corporation, Chief Engineer NHAI, Secretary Health Department, Secretary, Education Department and two non-government members (GRSA "Organisation" 2023).

The Organizational Structure of the GujROSA is as follows:

Figure 8.2c: Organizational Structure of GujROSA
Source: GujROSA

8.2 INTERVENTIONS:

The following interventions have been implemented under the Safe Corridor Demonstration Project:

8.2.1 Institutional Strengthening

To enhance road safety planning and implementation, Gujarat established Centers of Excellence (COEs) as part of the GHSP II initiative. These COEs aimed to facilitate the dissemination of sector-wide knowledge. They achieved this by collaborating with local experts, also known as 'faculty partners,' in the fields of Road & Bridge Design Innovation and Construction Management. Gujarat established two COEs dedicated to supporting research in road safety. The primary responsibilities of these COEs were problem-solving, research, and innovation. To fulfill their objectives, they actively engaged educational institutions, industry experts, government stakeholders, and citizens. (World Bank ICR 2021) With the engagement of education institutions, industry experts, government stakeholders, and citizens, the COEs ensured that relevant government, private sector, and other such stakeholders had ready access to information on global good practices for road safety (Roads and Buildings Department 2017).

DBFOMT at Mehsana-Himatnagar:

The Design-Build-Finance-Operate-Maintain-Transfer (DBFOMT) partnership model facilitated private sector participation and investment in public works maximizing finance for the development of the project. This model comprised two years for construction and ten years for maintenance works. (World Bank ICR 2021). This model also involved annuity payments for the concessionaire. The Mehsana-Himatnagar project was implemented under the DBFOMT format (World Bank ICR 2021).

8.2.2 Data Analysis:

An assessment of the existing risks to road safety on the stretch, using the automated iRAP (International Road Assessment Program) technique, was carried out for the three project roads. (World Bank ICR 2021). Manual safety audits were also conducted on the corridors. The vulnerabilities concerning non-signalized intersections, pedestrian crossings, and on linear villages and settlements were identified on the Mehsana-Himatnagar Corridor (iRAP 2019). On the Bharuch-Dehgam corridor and the Gandhinagar-Koba-Indira Bridge, the assessment revealed that vulnerable road users such as pedestrians, cyclists, and motorcyclists faced the greatest risk (World Bank PAD 2013).

8.2.3 Engineering

Based on the iRAP assessment, various safe engineering measures were integrated into the project design for all three corridors. These measures included adequate signage, marking and safety devices (e.g. delineators, crash barriers, hazard markers), channelization of turning vehicles in the intersections, footpaths and raised pedestrian crossings, dedicated segregation facility for slow-moving and vulnerable road users to name a few. The effectiveness of these design interventions will be closely monitored during the project operation stage and would be suitably modified and mainstreamed (World Bank PAD 2013).

The following interventions were undertaken at the Bharuch-Dehgam Corridor (Roads and Buildings Department 2020):

- The redesign of intersections was undertaken with traffic control measures like traffic channelization, colored pavement, night-time safety, and traffic signages/signals to name a few.
- Before improvement, the project road had a narrow closed drain along the corridor with a 1.2 meter top width. To utilize the top width of the closed drain as a footpath, a gabion wall structure was proposed to widen it to a width of 1.8 meter. This facility was implemented on both sides of the corridor with a pedestrian railing.

- Accessible Push Buttons have been installed (testing stage to help pedestrians cross the roads safely and as an aid for physically-challenged pedestrians.
- An alternate parking facility was provided for the motorists.

At the Gandhinagar-Koba-Indira Bridge the interventions included (Roads and Buildings Department 2020):
- Intersections were improved by the installation of traffic signs and through providing acceleration, deceleration, and shelter lanes for intersections and access roads. Traffic calming measures like rumble strips were installed at the crash-prone zones
- For pedestrian safety, footpaths and staggered and raised pedestrian crossings were installed on the project road.
- W-Beam crash barriers were installed to protect vehicles from going off the road.
- Road studs, delineators, 3D pavement markings, and colored markings were installed for turning traffic to reduce interaction between vehicles at intersections. To improve visibility and warn the drivers, LED blinkers were installed at critical locations.
- Delineated bus stops were constructed along with bus bays for the safety of those boarding and deboarding the buses.

At the Mehsana-Himatnagar Corridor the following interventions were undertaken:
- The existing two-lane road was upgraded to a four-lane one with a concrete barrier dividing the two directions of traffic flow. The chance of a head-on collision was reduced by the new, better road infrastructure, which is a four-lane broad road with a concrete barrier in the median. The likelihood of a run-off crash was decreased by the introduction of demarcation (road markings and signage), paved shoulders, and earthen shoulders on the roads. This activity was undertaken using the Design-Build-Finance-Operate-Maintain-Transfer (DBFOMT)

contract, comprising two years of construction and ten years of maintenance (Roads and Buildings Department 2018). This model facilitated private sector participation and investment in public works maximizing finance for the development of Gujarat.

- Improvements at Roundabout - A well-designed roundabout with splitter islands and a pedestrian crossing facility substituted the four-leg intersection at 126.9 km. Additionally, street lights and blinkers were installed in the roundabouts along this road to draw the attention of oncoming motorists (iRAP 2019, SH-55).

- For better visibility, the intersections, traffic signs, and road markings have all been improved. All horizontal curves are provided with better delineation. To help lower the probability of run-off crashes on such curves, chevron signs were installed to the outer edge and better road markings were added. The probability of head-on collisions was reduced on the road portions with such curves by installing concrete barriers on the median.

- Pedestrian crossing and road calming measures for the safe movement of pedestrians - Stretches near bus bays and road intersections were provided with marked pedestrian crossings, and median refuges to reduce the risk of pedestrians being hit by vehicles while crossing the road. Street lights were provided for increasing the night visibility. Thermoplastic painted strips as traffic calming measures were also provided a few meters before such intersections on both carriageways of the roads (IndiaRAP 2019, SH-55).
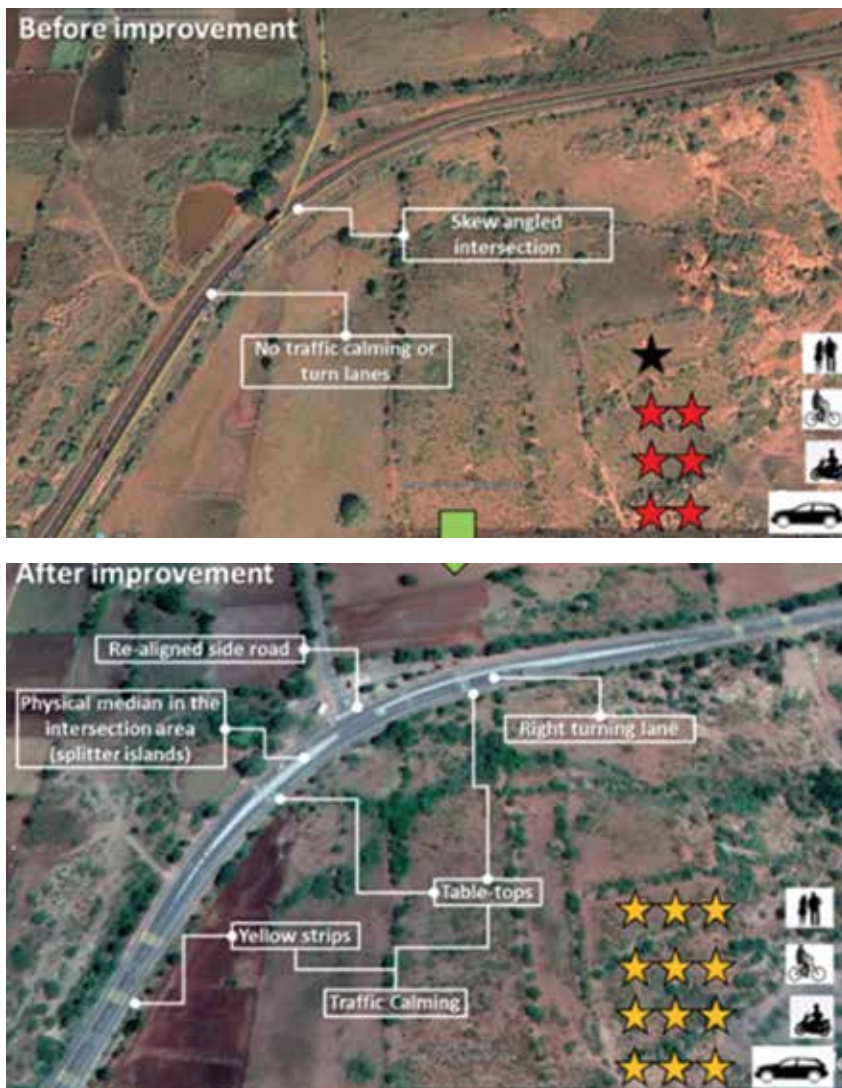
Figure 8.3: Mehsana-Himatnagar: Before and After iRAP rating
Source: (IndiaRAP 2019, SH-55)

8.2.4 Enforcement:

At the Bharuch-Dehgam stretch (Roads and Buildings Department 2020):

- Intelligent Transport System (ITS) interventions were implemented on the corridor. This was implemented in coordination with the Gujarat Home Department. A "Control

Command Center" was established at Bharuch to manage and operate the ITS Systems including the Video Management System, Variable Message Sign (VMS), traffic signals, and traffic violations.

At the Gandhinagar-Koba-Indira Bridge (Roads and Buildings Department 2020):
- Intelligent Traffic Systems (ITS) Interventions and Variable Message Signs (VMS) were used for better traffic management. They both provide and display real-time road information regarding current routes and all alternate routes to help road users make informed decisions.
- Wildlife Detection and Warning Systems were also installed to minimize human-animal conflicts on roads that lead to severe road crashes.
- Speed violation detection and warning systems were used along the stretch to check overspeeding.
- Emergency Callbox systems were installed to help connect to the nearest authority in case of an emergency.
- Pedestrian push-button systems at crossings were added to help pedestrians cross roads and avoid crashes at intersections (The Times of India 2022).

8.2.5 Education/Engagement:

Since 2010-11, Commissionerate of Transport (CoT), GoG is implementing a unique initiative related to Traffic Education and Awareness Mobile (TEAM) van under which 21 TEAM vans have covered 17,020 schools and 38,142 public places reaching out to 28,81,339 students and 5,574,583 citizens (GRSA "Road Safety" 2023). 196 Road Safety Fairs were also organized to create awareness among people. Education and awareness campaigns were run through various measures such as newspapers, FM Radio, and All India Radio. Marathons and street plays were also organized to promote road safety. Medical Camps and eye check-up camps were arranged for drivers. Helmet distribution drives were also conducted in the State.

8.2.6 Emergency Medical Care:

Enhanced post-crash safety (Roads and Buildings Department 2018) services have been designed in detail and implemented in the demonstration corridors to improve the survivability of road crash victims as well as their long-term recovery prospects. These services include:

- First responder training programs for those aside from local health workers most likely to be at the crash scenes (e.g., taxi drivers, local businessmen, and traffic police).
- Enhanced emergency response mechanisms.
- Preparation of a detailed action plan for the Health Department (including required training, equipment procurement, and implementation resourcing requirements) for:
  - Establishment of trauma registries in hospitals along and/ or in the vicinity of the corridor(s).
  - Establishment of computerized road traffic injury monitoring systems in health facilities along and/or in the vicinity of the corridor(s) for consideration by Health Department.

The Gujarat State Emergency Medical Services Act, 2007 was introduced to bolster the emergency medical services in the State. Under the Act, the Gujarat Emergency Medical Services Authority was established. The Authority consists of members from the Health and Family Welfare Department, Home Department, Legal Department, Indian Medical Association Gujarat branch, private doctors, Gujarat Nursing Council, and the Disaster Management Department, to name a few. The Act also calls for the constitution of City and District Emergency Medical Services Councils to ensure the provision of emergency medical services in the city or district, prepare plans for the implementation of emergency medical services, establish trauma centers, and supervise the existing medical system.

8.3 TEAM STRUCTURE AND STAKEHOLDERS:

For the Bharuch-Dehgam and Gandhinagar-Koba-Indira Bridge implementation, unit details are unavailable. The broad stakeholders include:

- Gujarat Roads and Buildings Department
- World Bank

The project implementation unit for the Mehsana Himatnagar Corridor comprised of:

1. Chief Engineer (World Bank) - having the overall responsibility for policy guidance, coordination, and planning, internal monitoring
2. Superintending Engineer (SE)
3. Executive Engineers assisted by an Environmental Specialist and a Social Specialist.
4. An Environment Social Management Unit (ESMU) was set up by the Roads and Buildings Department with the project implementation unit to look into the social and environmental aspects of the project, for overall policy guidance, coordination and planning, internal monitoring, and overall reporting of the project (World Bank PAD 2013).

8.4 PROJECT FUNDING:

Safe Corridor Demonstration Project Cost of Civil Works:

The actual cost of the Road safety component of the entire project with included the three corridors, namely, Bharuch Dehgam, Gandhinagar-Koba-Indira Bridge and Mehsana Himatnagar Corridor was USD 13 million (INR 952 million). Out of this, World Bank provided USD 10.9 million (INR 798.1 million) and the Government of Gujarat spent USD 2.1 million (INR 153.8 million). (World Bank ICR 2021)

The budget allocated for the design, upgrading to four lane, operation and maintenance of the existing state highway -55 to 4-lane from Mehsana to Himatnagar on Design, Build, Finance, Operate, and Transfer (Annuity) basis with horizontal and vertical alignment improvements, widening and strengthening, construction of new pavement, construction and/or rehabilitation of major and minor bridges, culverts, road intersections, interchanges, drains, road safety enhancements, until the transfer at the end of the Concession Period (2028), was INR 25,25,00,000 (USD 3,448,511) (R&BD 2016).

The source of financing and phasing of capital cost was INR 3,160,000 (USD 43,288) (World Bank ICR 2021). Here it must be noted that due to limited secondary information, final cost based on actual expenditure could not be captured.

8.5 REPLICABLE PRACTICES:

- **DBFOMT approach:** The DBFOMT partnership model was an effective measure to facilitate private sector participation, ensure the inclusion of maintenance in multi-year periods, and ensure the sustainability of road assets developed under the project (World Bank ICR 2021). Such partnership models can be replicated for swifter and more efficient measures to improve road safety on the ground.

- **Powers of Road Safety Lead Agencies:** GujROSA coordinated with multiple departments of the State such as the Transport, Home, Urban Development, Education, Health and Roads and Buildings departments, along with the National Highway Authority of India. Such as with GujROSA, lead agencies must be empowered to not only prescribe and oversee road safety standards and projects but also to penalize non-compliance by other departments and institutions. While road safety lead agencies do exist in other States, the accountability aspect needs to be strengthened nationwide by providing additional

powers to the State-level road safety authorities to penalize implementing agencies for non-compliance. This is in addition to the functions of the lead agencies according to the SCCoRS order No.16/2016/CoRS (SCCoRS 2016).

- **Establishment of Centers of Excellence (COEs):** COEs were established in Gujarat as part of the GHSP II to facilitate sector-wide knowledge in road safety planning and implementation. These COEs involved engaging local experts or 'faculty partners' in Road & Bridge Design Innovation and Construction Management. Through these COEs, there will be ready access to information on global good practices for the government stakeholders, as well as private sector companies, contractors, and vendors, to name a few (Roads and Buildings Department 2017). Such COEs can be established nationwide for easy access to road safety information and research support on road safety interventions.

8.6 KEY LEARNINGS/LESSONS LEARNED

- **Careful selection of project corridors for interventions:** One of the SCDPs had to be replaced with the Gandhinagar-Koba-Indira Bridge this caused a delay in the implementation of the project. Identification of corridors is a challenge- as the previous corridor that was considered a part of the SCDP was later included in the National Highway network, and ownership was transferred to NHAI. To achieve road safety targets in a time-bound manner, delays in the implementation of the projects should be avoided. Therefore, project sites should be selected in a manner that such delays can be avoided, and road safety targets can be met within the designated time frame.

Case Study 9:
TAMIL NADU

Uthiramerur - Kannamangalam Corridor (SH 118A) Tamil Nadu Road Sector Project - II

In Tamil Nadu, the 95.6 km stretch of the Uthiramerur-Kannamangalam corridor witnessed interventions across the 4 Es to improve the road safety scenario. The project resulted in a reported improvement in the safety standards of the stretches. The project was managed under the Tamil Nadu Road Sector Project-II.

1 | KEY DATES: THE PROJECT WAS APPROVED ON 28TH APRIL 2015, STARTED ON 10TH JULY 2015 AND WAS COMPLETED ON 30TH JUNE 2021.

2 | AREA COVERED: FOUR ROADS OF LENGTH 95.6 KM STRETCH IN KANCHIPURAM AND TIRUVANNAMALAI DISTRICTS
a. UTHIRAMERUR - KANCHIPURAM
b. KANCHIPURAM - CHEYYAR
c. CHEYYAR - ARANI
d. ARANI - KANNAMANGALAM (WORLD BANK 2023).

3 | SCOPE OF REPLICATION: CAN BE IMPLEMENTED ON HIGH-SPEED HIGHWAYS TO IMPROVE OVERALL SAFETY.

9.1 ABOUT THE PROJECT:

Tamil Nadu Road Sector Project (TNRSP) is a collaboration between the World Bank and the State's Highway Department. The first phase was underway from 2003 to 2012, under which multiple road safety and institutional strengthening activities were undertaken. These included training of officials in road safety management (World Bank ICR 2012). It also laid the foundation of the pioneering Road Accident Database Management System (RADMS) (World Bank ICR 2022).

Following the success of TNRSP-I, the TNRSP-II was initiated in 2015, under which two districts and a corridor were selected for intensive road safety interventions based on the iRAP assessment (World Bank ICR 2022). The interventions dealt with speed management, risk-targeted patrol plans, campaigns, helmet usage, and trauma care training and services.

9.2 INTERVENTIONS

9.2.1 Engineering Measures

1. Identification of Black Spots: 233 blackspots were identified between 2016 and 2018. These were then rectified by the State Highways Department. 103 engineers were trained in road safety audit techniques (Srinivasan 2020).
2. Improvement of Road Sections: From 2014-15 to 2017-18, the Government of Tamil Nadu worked towards the improvement of around 5,400 vulnerable sections under the Core Road Infrastructure Development Programme (CRIDP) and special road safety programs (Srinivasan 2020).
3. Mandatory Speed Humps: All access roads were mandated to have speed humps.
4. Road safety audits and follow-up actions were monitored on State Highways.

1. Documents Reviewed:
a. Tamil Nadu Road Sector Project - II website.
b. World Bank ICR Report 2022.
c. World Bank Presentation by Krishnan Srinivasan, 2020.

5. Speed Calming Measures: Safety and speed calming measures were incorporated into the road design (World Bank ICR 2022).

6. Illuminated Raised Pavement Markers on the center and edge lines, delineators, hazard markers, and chevron signs were installed on the project road (Srinivasan 2020).

7. Designated timelines were set for repairing damaged road furniture and non-compliance with timelines amounted to payment cuts (Srinivasan 2020).

8. Authority engineers were authorized to stop work if it threatened the safety of users and pedestrians.

9. Bus Stops and Bays: Bus stops with ramps, clearly demarcated guardrails and bus bays, and footpaths were constructed on all project roads. Illuminated raised pavement markers on center and edge lines, delineators, hazard markers, and chevron signs were added to protect all road users (Srinivasan 2020).

Figure 9.1: Construction of bus stops with ramps and bus bays - before (left) and after intervention (right) (Source: Srinivasan 2020)

Figure 9.2: Installation of edge lines and raised pavement markings (Source: Srinivasan 2020)

9.2.2 Enforcement Measures

1. A State-level control room was activated that monitored 272 highway patrol vehicles.
2. In 2017, one of the enforcement measures stated by the State government included framing criminal charges for consignees and consignors for vehicles with protruding rods.
3. Speed-measuring radar guns were used for enforcing speed limits in some places. Fines were imposed on vehicle drivers crossing permissible speed limits.
   Other strictly enforced regulations include:
   a. E-challans issued through smart POS integrated with VAHAN and SARATHI databases.
   b. Maximum working hours of tourist/maxi cab drivers enforced.
   c. Closure of wine shops along highways to prevent drinking and driving.
   d. Tougher guidelines for revocation of suspended licenses.
   e. Suspension/cancellation of licenses for speeding, jumping red light, drinking, and driving, the use of mobile phones while driving, and overloading/carrying passengers in goods vehicles (Srinivasan 2020).
4. The enforcement equipment procured included:
   a. Electronic speed enforcement and incident management on the East-Coast Road.
   b. Modernized equipment and tools for enforcement in Kanchipuram and Tiruvannamalai.
   c. Patrol vehicles, breathalyzers with attached printers, laser speed guns.
   d. Vehicle-mounted and body-worn cameras, dragon lights, and LED batons.
   e. Hydraulic Combi tools for post-crash recovery.
   f. Driving simulators for HMV and LMV driver testing in two districts (Srinivasan 2020).

9.2.3 Education/Engagement:

Various State government measures were taken up to improve road safety awareness and education:

1. 8 senior officials attended the road safety management leadership program (Australia).
2. Road safety training programs were conducted in blackspots of two locations-Kanchipuram and Tiruvannamalai.
3. The Tamil Nadu Transport Department conducted various awareness/training programs on road safety in consultation and collaboration with various other departments for schoolchildren, bus drivers and conductors, auto drivers/two-wheelers/STU drivers/stage carriage drivers, police training constables, LLR Applicants, and Amma scooty beneficiaries (ECORYS 2019).
4. Some of the major programs conducted by the transport department are as follows:
   a. Vehicle rally, Helmet rally
   b. Rallies on road safety by NSS, Red Cross, and students
5. Road safety has been incorporated into the class curriculum (Class 1 – 12).
6. Two-wheeler showroom dealers have dedicated "Road Safety Corners" in their establishments to augment road safety awareness among two-wheeler buyers.
7. Awareness programs were conducted for 297 schools in the Kanchipuram district. (Srinivasan 2020).

9.2.4 Emergency Medical Care

1. A Center of Excellence in Trauma Care was set up at Kanchipuram District Headquarters Hospital and Tiruvannamalai Medical College Hospital.
2. First responder training was provided at Blackspot locations in Kanchipuram and Tiruvannamalai.
3. Doctors and nurses were trained in ABCDE (Airway, Breathing, Circulation, Disability, and Exposure) concept of trauma reception/resuscitation for life-saving (Srinivasan 2020).

9.3 PROJECT IMPLEMENTATION

The project is headed by the Project Director, who is assisted by the Chief Engineer. Below the Chief Engineer are two Superintending Engineers further assisted by Field Officers.

9.4 REPLICABLE PRACTICES:

Selection of high-fatality zones as the locations for conducting training programs: Locations needed to be selected for the training sites. There is a larger likelihood of people witnessing crashes at blackspots or high-fatality zones, as the incidence of road crash injury is high at such spots. First aid administered during the Golden Hour by a bystander can make a significant reduction in the risk of death and permanent injury. Therefore, the training was conducted at such blackspots to ensure that the first responders (i.e. either the police monitoring the location or people residing near the location) were trained in basic first aid methods. State-level control room for managing vehicles.

Chapter IV:
City and Network- Based Practices

In this chapter, we delve into two separate approaches, apt for two different sets of road safety scenarios. In the first instance, the road safety measures put in place are city-specific and cater to the unique road safety issues witnessed within a specific city to address them via the apt interventions. Cities differ with regard to the types of road crashes witnessed within their limits. While most reasons fall within the 4E's of road safety, they are nuanced in a manner specific to the city and the exact spots where road crashes are being registered. To tackle road crash deaths at the city level, MoHUA also launched the City investments to Innovate, Integrate and Sustain program (CITIIS) in 2018. This initiative is nested as the main component of "program to fund smart city projects through a challenge process". It aims to supplement the smart cities mission by supporting the shortlisted SPVs in key projects including safe and sustainable mobility. For example, under safe and sustainable mobility, the CITIIS Initiative involved the Dehradun Child Friendly City Project to make the commute to schools, parks, and other public spaces safe for children with an emphasis on accessibility and mobility.

The second approach is suitable for instances wherein several road segments within a defined zone display similar road traffic crash patterns and safety challenges. Usually, these connected road segments are part of a tourist or religious road circuit that witnesses regular or seasonal thoroughfare, both pedestrian and vehicular. The introduction of network-based interventions in

such zones helps address the predictable movement within this circuit as well as the road user peculiarities, seasonal increase and decrease in movement, and landscape specifications that directly and indirectly impact the road safety scenario, apt interventions as well as the post-crash emergency care provisions.

The detection of all factors that contribute towards making these circuits unsafe and then addressing them within the road safety category that they fall under allows for targeted and efficient use of resources and coordinated efforts to tackle regional road safety concerns. Usually, the primary focus in such instances is on strict enforcement and efficient traffic management to address the significant influx of visitors who may not be following traffic rules or may be unfamiliar with the terrain and directions and may end up driving in an unorganized and unruly manner. To address such situations, an adequate number of dedicated enforcement personnel is crucial. For example, in the Sabarimala Safe Zone project, the decrease in road crash deaths can be attributed to enforcement teams deployed in the zone, ensuring round-the-clock monitoring and enforcement of traffic rules and regulations. Additionally, establishing a robust network of ambulances and medical facilities is essential to handle any emergencies effectively and provide timely medical care for ensuring immediate and effective post-crash assistance.

Case Study 10:
KOLKATA

Safe Drive, Save Life Campaign

The city of Kolkata saw 4,104 crashes and 407 deaths in 2016. Interventions across the 4E's were implemented in the city, which resulted in a 51.8% reduction in deaths from 2016-2021. The Police Department was the primary implementing agency.

1 | **KEY DATES: THE PROJECT WAS LAUNCHED IN 2016 AND IS STILL ONGOING**
NOTE: IN THIS STUDY, THE INTERVENTIONS AND IMPACT UP TO 2019 HAVE BEEN CONSIDERED
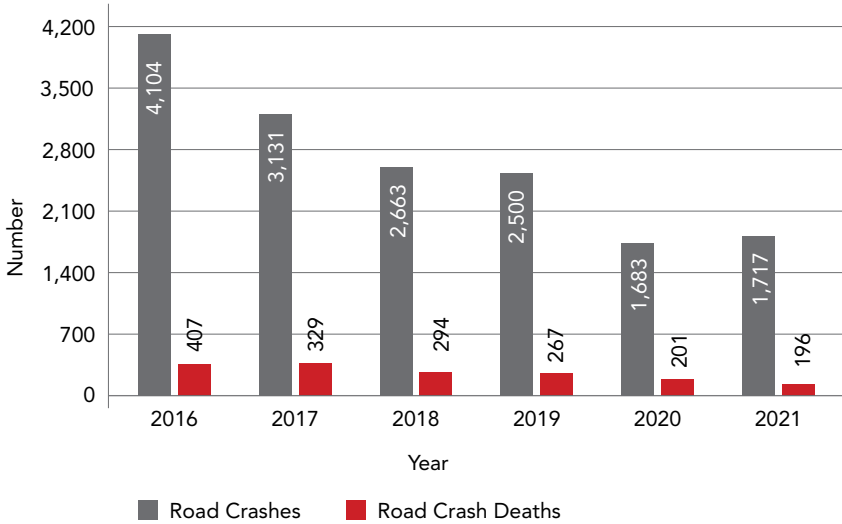
2 | **AREA COVERED: KOLKATA CITY**

3 | **IMPACT: REDUCTION IN ROAD CRASH DEATHS BY 51.8% FROM 2016 TO 2021**

4 | **SCOPE OF REPLICATION: CAN BE IMPLEMENTED IN MILLION-PLUS CITIES WITH A HIGH BURDEN OF ROAD CRASHES**

Road Crashes and Road Crash Deaths - Kolkata

Graph 10.1 Road crashes and deaths in Kolkata (2016-2021)
(Source: "Road Accidents in India 2017" Report (MoRTH 2018) and "Road Accidents in India 2019" Report (MoRTH 2020))

10.1 ABOUT THE PROJECT

Kolkata city, the capital of West Bengal with an area of 1480 km^2, witnessed a total of 4,561 crashes in 2014. Interventions across the 4 Es of road safety, enabled the city to reduce the number of road crash deaths by 51.8% between 2016 and 2021. The Safe Drive, Save Life Campaign (SDSL) is a significant step towards the Government's Vision to create a safe road network for all road users in the State to achieve a 'zero fatality figure' in the long run. Working towards its mission of reducing road crashes and deaths by 20% by 2020, the initiative enabled the State capital, Kolkata city to reduce the number of road crashes by 45% between 2017 and 2021. The Safe Drive, Save Life campaign was introduced in a workshop on the 8th of July, 2016, from Nazrul Mancha in Kolkata by the honorable Chief Minister of the State (Transport Department, Government of West Bengal 2023).

1. Documents verified: KPMG Evaluation Report 2019

2. For this case study, the average exchange rate for 2023 (until July 2023), where $1=Rs. 82.2 has been considered

The SDSL initiative was initiated with the main objectives of reducing deaths and injuries by road crashes with special attention to Vulnerable Road Users by improving road engineering and design, management, road safety awareness, emergency care, and law enforcement. They also aim at designing and implementing an Accident Information System and developing a framework for coordinated actions by relevant departments and ensuring accountability, funding, and research.

10.2 INTERVENTIONS

10.2.1 Road Safety Management And Data Analysis

1. In 2018, the Kolkata Traffic Police engaged a private analytics firm, JP Research India Pvt. Ltd., to analyze road crashes in the city and give recommendations based on the same. Their recommendations were as follows:

a. 50% of the road crashes were caused due to engineering deficiencies such as poor road markings and signages (18%), poor pedestrian infrastructure and crossings (18%), and poor intersection design (14%). Based on the issues, the agency recommended infrastructural changes and improvements at crossings, such as road markings and signages.

b. Run-over of two-wheeler users, pedestrians and bus occupants by vehicles constituted 30% of the total fatal road crashes in the city. Thus, installation of run-over prevention devices, which have a potential of avoiding such run-overs by Kolkata city buses was recommended.

c. Vision obstruction due to vehicle interiors caused 18% of all road crashes. They create blind spots that occur in the front of the driver due to the A-pillar of the vehicles and inadequate coverage in the side and rearview mirrors. Thus, it was recommended that mirrors should be installed at all blind spots for enhanced visibility (JP Research Institute Pvt. Ltd. 2019).

Decision-Making Tool:
Crash Data from the Police Department

Enabler:
Directions by the Chief Minister (All India Trinamool Congress 2016)

Validation mechanism:
An evaluation was conducted by KPMG and a report was published in November 2019. The report evaluated the Safe Drive Save Life Campaign using the PARRKS (Positivity, Attitude, Reach, Recall, Knowledge, Success/Outcomes) Evaluation Framework.

Figure 10.1: Internal mirrors installed in buses to cover blind spots
Source: JPRI Kolkata City Accident Study)

Figure 10.2: S1 Guard - Run-over Prevention Device

10.2.2 Engineering

1. In order to reduce road crashes caused due to overspeeding and dangerous objects on the roadside, the Engineer-in-Chief, PWD issued instructions regarding engineering measures for road safety. These measures pertained to the removal of dangerous objects on the roadside and the installation of speed calming measures, road markings, and signages. In this regard, 5% of the allocated fund for every forthcoming road project, and a portion of the State Road Safety Fund is to be used for road marking and signs. In 2017, the State allocated 22 Road Marking Machines, 15,165 liters of road marking paint, and 1,809 road signages from the Road Safety Fund (KPMG 2019).

2. An Interdepartmental Committee was set up in 2017, which devised a protocol for fixing speed limits, signages, and lane driving on all national highways, State highways, and other roads (KPMG 2019).

3. As a step towards road safety capacity building, consultants, contractors, concessionaires, and engineers involved in the planning, design, construction, and operation of Highways were trained.

10.2.3 Enforcement Measures (KPMG 2019)

1. The Police counseled offenders, particularly those who were found not using road safety devices such as helmets, and seatbelts. In 2018, 15% of those violating helmet rules and 19% of those violating seat-belt rules in Kolkata were counseled by the police.

2. The Transport Department and the Police worked jointly to conduct random checks to prevent cases of overloading. These checks were conducted both during the day and night time on roads where commercial vehicles plied regularly.

Figure 10.3: Challans being issued for overloading of trucks
Source: KPMG Evaluation Report

3. In the Kolkata city, 13 Red Light Violation Detection (RLVD) cameras were installed. Apart from detecting red light violations, these cameras also capture the registration number of vehicles traveling at 100 kmph even at night (Telegraph India 2018).

4. All existing motor training schools were audited and categorized based on their level of compliance with the Central Motor Vehicle Rules, 1989. They were sorted according to the following:
   • Category A - 80% compliant
   • Category B - 51% - 80% compliant
   • Category C - Less than 50% compliant (KPMG 2019).

10.2.4 Education/Engagement

1. To sensitize citizens, the government issued a letter to all multiplexes/cinemas for running short films/clippings on road safety at the beginning of each show (KPMG 2019). The Kolkata Police prepared various short films and clippings on road safety to be played in different public spaces. In December 2017, rallies were also organized in this regard.

2. A 'No Helmet, No Petrol' rule was implemented by the Kolkata police to encourage helmet usage amongst two-wheeler users, both drivers and the pillion riders (NDTV 2016).

Figure 10.4 Rally conducted under the SDSL Campaign (Source: KPMG Evaluation Report)

3. Driving instructors were trained by experts from IIT Kharagpur under the Safe Drive Save Life Campaign in not just Kolkata but all districts of the State. It saw the involvement of the Kolkata Police, Regional Transport Offices (RTOs), academics, and medical professionals apart from motor training schools (Citizen Matters 2018).

10.2.5 Emergency Medical Care (KPMG 2019):

1. In 2018, the West Bengal government inaugurated the primary comprehensive trauma care center at the RG Kar Medical College and Hospital in Kolkata. This center, along with 45 other hospitals in the State (one in each district) were designated as Trauma Care Centers. Here, 70 beds are dedicated to trauma care patients and a fully equipped resuscitation facility is also present (The Times of India 2017).
2. The Health Department has initiated regular eye-testing and general check-ups for drivers to help avoid potential road crashes.

3. An initiative outside of Kolkata, named Patha Bandhu, was undertaken by the Health Department to train residents around identified blackspots in first aid delivery to road crash victims. Trainees were provided with a kit comprising a torch, a safety jacket, and a first aid kit along with the necessary information to use the kit when required. In the 1st phase, 100 black spots were identified in Howrah, North 24 Parganas, West, and East Midnapore for the Patha Bandhu initiative. Approximately 7-8 citizens from each black spot were to be trained.

4. In 2019, a toll-free hotline number was initiated by the Health Department. Based on the requirement, the Health Department coordinates with relevant Government departments to dispatch relief or medical services to the crash spot.

The following activities have been undertaken after the 2019 (evaluation year):

1. Commercial vehicles (buses, taxis) registered before 2018, were mandated GPS installation before March 2023. Those registered in 2019 or after were mandated to get them installed by the end of 2022 (Telegraph India 2022).

2. In January 2023, the Kolkata Traffic Police announced workshops for three- and four-wheeler commercial drivers in 50 crash-prone areas where real-time violations are shown through CCTV footage, and remedial measures are to be suggested (Times of India 2023).

3. A campaign to raise road safety awareness was conducted on 10th February 2023, by the Kolkata Police's South Traffic Guard (Telegraph India 2023).

4. The Government of West Bengal declared the initiation of an ambulance service dedicated to road crash victims in December 2020. The government planned to start the service with a total of 150 ambulances and the target was to deliver the victim to the nearest emergency medical center within 15 to 20 minutes of receiving the call (Millennium Post 2020).

10.3 PROJECT STAKEHOLDERS:

The activities under the Safe Drive, Save Life Campaign are being implemented through a three-tier system. The State Road Safety Council functions at the apex level, followed by the Nodal Department with support from the Project Management Unit and finally a lead agency (comprising senior personnel from related government departments) and the District/Panchayat/Urban Local Body Road Safety Committee function at the lowest rung (KPMG 2019).

10.4 PROJECT FUNDING

The total fund allocated to the Road Safety Fund from 2016-17 to 2018-19 was INR 2.1 billion (USD 25.6 million) (KPMG 2019). While the figures for the total funds allocated to the Road Safety Fund are available, figures for utilization of funds for road safety interventions in Kolkata are not included in this study.

10.5 REPLICABLE PRACTICES

- **Conducting training to deliver first-aid to road crash victims:** The "Patha Bandhu" campaign by the Health Department was initiated in cities around Kolkata (eg. Howrah) to train citizens residing around identified black spots on methods to deliver first-aid to road crash victims. The trainee citizens were to be given kits which comprised a torch, a safety jacket, a first aid kit, and a manual for imparting first aid when required. Approximately 7-8 citizens from each black spot are to be trained in the first phase. As citizens residing near black spots witness more road crashes than average, this project can be scaled up nationally to cover all blackspots.

10.5 KEY LEARNING

- **Learnings from implementation of the "No Helmet, No Petrol" campaign:** The West Bengal government introduced a set of useful initiatives to counter road safety concerns. One of these was making petrol availability conditional on helmet use through the "No Helmet No Petrol" campaign. Two-wheeler drivers not using a helmet were not allowed to get petrol refills in the Kolkata police jurisdiction. However, the onus of implementation of such a campaign should be on the State government, and they should also support petrol pumps to implement the campaign. For example, it was reported that in Kolkata, the campaign led to discord between suppliers and petrol pump owners (The Telegraph 2023). To prevent such discord, State enforcement is required.

Case Study 11:
KERALA

Sabarimala Safe Zone

The "Sabarimala Safe Zone", which includes the roads connecting to the Sabarimala Temple witnessed 16 deaths between 2009-10. Interventions across the 4E's were implemented on the zone, which resulted in the zone witnessing zero deaths for two consecutive years i.e. 2019-2021. The project was managed by the Kerala Motor Vehicles Department.

1 | KEY DATES: THE PROJECT COMMENCED ON 15TH NOVEMBER 2010 AND IS ONGOING (KMVD 2022)

3 | IMPACT: 100% REDUCTION IN DEATHS, FROM 16 IN 2009-10 TO 0 IN 2020-21. 91% REDUCTION IN INJURIES (2009-2021) (KMVD 2022)*

2 | AREA COVERED: INITIATED WITH AN AREA OF 200 KM AND HAS BEEN EXPANDED 400 KM AREA AROUND SABARIMALA INCLUDING PATHANAMTHITTA, KOTTAYAM, AND IDUKKI DISTRICTS IN KERALA

4 | SCOPE OF REPLICATION: THE PROJECT CAN BE USED AS A MODEL TO IMPROVE SAFETY IN HIGH-DENSITY TOURIST SITES SUCH AS PLACES OF RELIGIOUS IMPORTANCE OR MONUMENTS

*From 77 injuries in 2009-10 to 7 injuries in 2020-21

Road Crash and Road Crash Deaths - Sabarimala safe zone
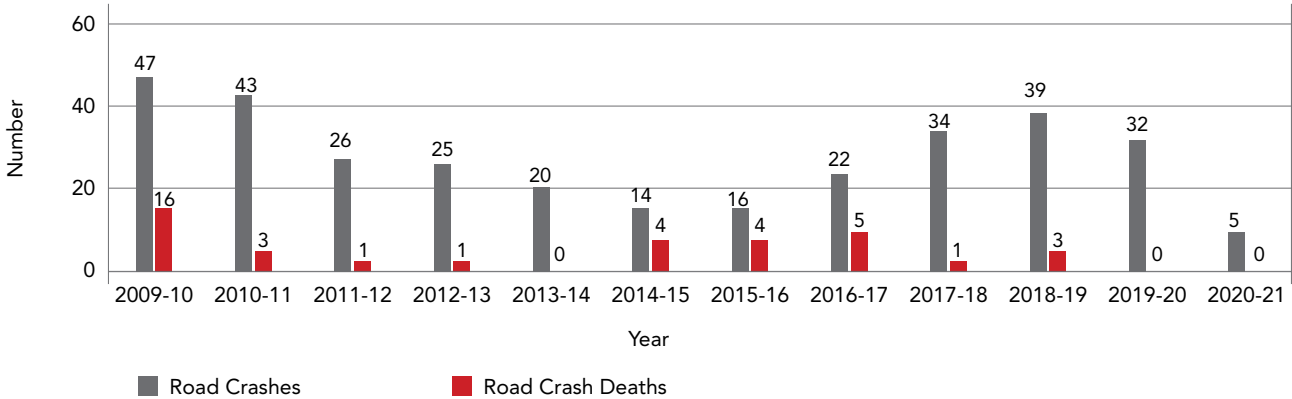

Graph 11.1 Road crashes and crash deaths in the Sabarimala Safe Zone from 2009-10 to 2020-21

11.1 ABOUT THE PROJECT

Sabarimala Safe Zone is a road safety project undertaken by the Kerala Motor Vehicles Department (KMVD) and the Kerala Road Safety Authority (KRSA) to ensure the safety of pilgrims during their travels to Sabarimala, from 15 November to 20 January every year. During the Sabarimala pilgrimage season, a huge traffic flow from neighboring States, particularly at border points on the Kerala highways such as Manjesweram, Wayanad, Palakkad, Kumily, Ariankavu, and Amaravila, is observed.

Since 2010, the project has been successfully implemented during the pilgrimage season, yielding positive results in terms of a reduction in road crash severity, a reduction in traffic delays, and an improved level of service on project roads. The visible presence of police personnel on the roads has also resulted in better road discipline and the orderly movement of tourist vehicles (KMVD 2022). As part of the project, a network of roads was targeted. The table below provides the list of stretches covered under the project along with their respective lengths:

1. Documents verified:
a. Questionnaire answered by Mr. S. Sreejit, Transport Commissioner, Kerala, 2022
b. Kerala Road Safety Authority Website.

2. For this case study, the average exchange rate for 2023 (until July 2023), where $1=Rs. 82.2 has been considered

	Table 11.1: List of stretches included in the network of the Sabarimala Safe Zone	
	Stretch Name	Length
1.	Pathanamthitta-Pamba route	66 km
2.	Erumeli-Pamba route	47 km
3.	Erumeli-Koratty-26th mile	12 km
4.	Erumeli-Pulikkunnu Mundakayam	12 km
5.	Erumeli-Vizhikkithodu KVMS Ponkunnam	19 km
6.	Kottayam-Kumily Road	110 km
7.	Sathram-Vandiperiyar-Kuttikkanam-Kattappana	16 km
8.	Kattappana-Kambamettu	24 km
9.	Kattappana-Kuttikkanam	40 km
10.	Cambammettu-Kumily	36 km

11.2 BACKGROUND

Sabarimala is a famous temple situated in the hilly Pathanamthitta district in Kerala (KRSA 2020) which is frequented by pilgrims for the Mandala-Makaravilakku festival. The winding roads leading to the temple cut through forests and urban centers in Pathanamthitta, Kottayam, and Idukki districts. Since the roads are narrow, bottlenecks in the form of traffic congestion caused by either vehicle pile-ups due to road crashes or vehicle breakdowns are frequent on the roads leading to the Nilakkal Base Camp. This hinders the operations of emergency vehicles, rescue and relief efforts, and servicing of stranded vehicles (KRSA 2020).

It is estimated that nearly 40 million pilgrims traveling in 8 million vehicles visit Sabarimala every season. Before 2017-2018, an average of 230 road crashes were reported in the control centers, leading to the death of 4-6 people at the zone and injuries to over 200 persons every season. Around 6,000-7,000 vehicles were getting stranded due to breakdowns (KMVD 2022).

Decision-Making Tool:
Data from State Crime Records Bureau

Enabler:
Kerala Road Safety Authority Act (2007)

Validation mechanism:
The impact was identified with the help of the Report of Safe Zone Project from Special Officer Safe Zone and data from the State Crime Records Bureau (KMVD 2022).

11.3 INTERVENTIONS

To obtain more details on the implementation of good practices across the 4-E's of road safety, a questionnaire was sent to the Kerala Motor Vehicles Department. Mr. S. Sreejit, Additional Director General of Police and Transport Commissioner, Kerala, responded to this questionnaire.

11.3.1 Engineering

Various engineering interventions such as signboards, blinker lights, and polychrome convex mirrors were installed on project roads to assist road users in identifying the road geometry (KMVD 2022).

11.3.2 Enforcement Measures

The project roads were covered with the regular presence of Motor Vehicles Department Executive Officers, who facilitated emergency help and induced drivers to drive carefully courtesy of enhanced perception of enforcement. 15 Patrol teams of 45 officers were deployed from Kerala Motor Vehicles Department with vehicles fitted with GPS, wireless, fire-extinguisher, and safety devices. The patrolling was done in 8 spells of 9 days each. Further, three 24/7 control rooms with communication facilities (KMVD 2022) were set up to handle citizen concerns on the Sabarimala Roads: the Safe Zone Main Control Office in Elavunkal and two sub-divisions in Erumeli and Kuttikkanam. A total of 24 squads functioned at the three sites round-the-clock (Government Department Services, 2023). The patrol squads ensured parking discipline and tended to vehicle pile-ups and crashes on road (KRSA 2020).

11.3.3 Education/Engagement

Road safety awareness campaigns were conducted among Guruswamis and drivers, and short articles were distributed in the Safe Zone area in six languages (Malayalam, English, Hindi, Tamil, Kannada, and Telugu) on major check posts, toll booths, edathaavalams (transit points), etc. Announcements have also

been arranged in the six languages in Safe Zone areas, patrolling vehicles, railway stations, etc. (Kerala Government 2023). A Public Address system and information boards were also established at all parking lots with multi-lingual announcements (KMVD 2022).

11.3.4 Emergency Medical Care
Ambulance services of the health department and the police were used for immediate rescue operations and to quickly bring the injured to the hospitals. Pilgrims can contact Safe Zone Helpline in case of emergency including road crashes. Ambulance service units were also arranged from Private medical institutions (KMVD 2022).

11.3.5 Other Road Safety Interventions
Breakdown assistance was provided to stranded vehicles using mechanical aid and crane service. Such vehicles were first removed from the site of the breakdown to prevent traffic congestion and then repaired free of charge. The Tire Puncture/Repair Mobile Unit at Elavunkal can repair vehicles weighing up to 40 tonnes (Kerala Government 2023). The administration collaborated with 35 automobile companies to set up a mechanical staff of 300 people in 90 mechanical teams (Kerala Government 2023), 3 mobile repair units with sufficient spares, and 5 cranes and 50 recovery vans. Arrangements for supplying fuel to stranded vehicles were also made on a payment basis (KMVD 2022).

11.4 TEAM STRUCTURE AND STAKEHOLDERS

This project involves the Transport/Road Safety Commissioner, the Additional Transport Commissioner, Joint Transport Commissioner (Enforcement), Deputy Transport Commissioner (South Zone), Regional Transport Officers (RTOs), Special Officer Sabarimala Safe Zone, and enforcement officers (KMVD 2022).

11.5 PROJECT FUNDING

The project has been funded by the Government of Kerala (KMVD 2022). The total amount spent in the first three years of the third phase of the project (400 km) was INR 2.82 crore (USD 343,065) (I&PRD 2019). The total funding included measures deployed under the four main road safety pillars viz. road engineering, police enforcement, emergency medical care, and road safety education and awareness.

11.6 REPLICABLE PRACTICES

- **Developing a Robust Enforcement Model:** The enforcement model of the Sabarimala Safe Zone project can be leveraged to improve road safety in areas where road engineering and road user education have limited effect. The project, without significant engineering work, managed to eliminate road crashes in Sabarimala for two consecutive years. Constant patrolling and coordination via control rooms were then clubbed with electronic enforcement and replicated by KMVD in all 14 districts in Kerala- under the Safe Kerala Project (KMVD 2022). Other State transport departments can also deploy similar enforcement models involving police personnel and motor vehicle inspectors to check traffic rule violations at scale.

- **Capacity building for emergency care:** The road crash burden seemed to come primarily from delays in emergency care and rescue work due to road congestion, arising out of a lack of rapid access repair services and prompt bystander care. To increase the capacity of emergency care at the zone, police officials and local medical facilities took on the responsibility to render emergency care and breakdown assistance to resolve road congestion at the zone. The Government of Kerala thus managed to enhance the emergency care on the stretch, and this was a factor that led to zero road crash deaths on roads leading to Sabarimala for two consecutive years. Therefore, such capacity-building measures can be deployed in zones with limited access to emergency care and high traffic congestion.

11.7 KEY LEARNINGS/LESSONS LEARNED

Enhancement of Enforcement Systems in areas other than the Safe Zone through Electronic Enforcement: Due to the demand for a high level of enforcement and the limited capacity of the police force, the MVD, and Police personnel have reportedly found it challenging to balance the burden of routine duties with the additional responsibility of operationalizing Safe Zone Project, especially in the districts of central & southern Kerala (KRSA 2023). To increase the capacity on the ground, the Kerala Police has recently taken steps such as the deployment of electronic enforcement in over 700 locations, to enhance capacity (India Today 2023). Thus, in cases when the manual enforcement capacity is low, methods for electronic enforcement need to be deployed. As per Section 136A of the Motor Vehicles (Amendment) Act, 2019, the Government of India has issued guidelines for States to adopt measures of electronic monitoring and enforcement. Therefore, States should deploy such measures in enhancing overall enforcement on the ground.

Chapter V:
State-Based Practices

The adoption of a State-based road safety project is an apt approach if the resources, both financial and human, require collaboration and coordination among multiple agencies and stakeholders. The success of such a project relies on the collective effort of government departments, law enforcement agencies, transport authorities, healthcare providers, community organizations, and other relevant stakeholders. By taking a holistic approach, a State-based road safety project aims to create a safer and more secure road environment for all users across the entire State.

High-ranking State government officials working towards improving the road safety situation in their State can plan and execute such projects with ease. By leveraging their ability to bring together all stakeholders, such officials can effectively implement interventions encompassing the 4 Es of road safety throughout their State.

Examples of instances where State-level interventions were adopted because road crashes were spread almost evenly across the geographical limits of the State, include Tamil Nadu, and Odisha. Both these States rank among the country's top 15 States in terms of road crash deaths, where comprehensive State-wide interventions have been implemented.

The economic capacity of any State plays a huge role in determining the type and magnitude of interventions deployed within its limits. For instance, in low-income States like Odisha, the focus is on maximizing reach across all sections of society while focusing specifically on areas that require targeted attention. Through initiatives such as the Vahak and Rakshak training programs, implemented with a modest investment of INR 12 million, the State successfully trained nearly 12,500 citizens in crash prevention and first responder care. Additionally, emphasis was placed on enhancing trauma care facilities. With a minimal investment of INR 7.2 per capita, Odisha reduced road crash deaths by 4.4% within three years. In the case of high-income States such as Tamil Nadu, the adoption of simultaneous interventions across the 4 E's is crucial, to work on the different problem areas simultaneously.

Case Study 12:
ODISHA

State Government Road Safety Initiatives

The State of Odisha witnessed 5,315 deaths in 2018. Interventions across the 4E's were implemented in the State which led to a 4.4% reduction in deaths in the State between 2018 and 2021. Multiple stakeholders are involved in improving Odisha's road safety such as the Transport, Police, and Health departments.

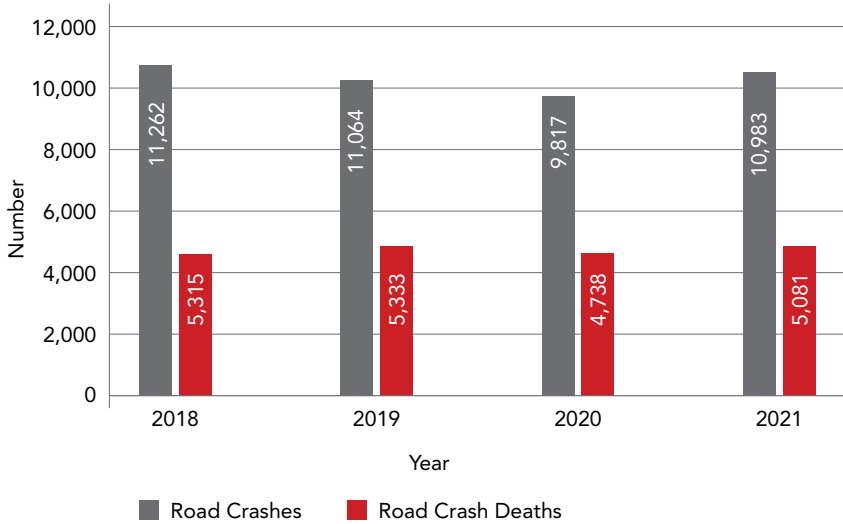**1** | KEY DATES: THE STUDY ANALYZES INTERVENTIONS IMPLEMENTED FROM 2018 ONWARDS IN THE STATE

3 | IMPACT: THE STATE WITNESSED A 4.4% REDUCTION IN THE NUMBER OF ROAD CRASH FATALITIES. BETWEEN 2018 AND 2021

2 | AREA COVERED: STATE-WIDE PRACTICE

4 | SCOPE OF REPLICATION: THE PROJECT CAN BE IMPLEMENTED IN LOW-INCOME STATES

Road Crashes and Road Crash Deaths - Odisha

Graph 12.1: Road crashes and deaths in Odisha (2018-2021)
(Source: Ministry of Road Transport and Highways)

1. Documents Reviewed:
a. Questionnaire answered by Mr. Sanjay Kumar Biswal, erstwhile Joint Commissioner Transport, Road Safety, Odisha, "Road Accidents in India, 2021" by MoRTH.
b. Odisha Lead Agency, 2023
c. Odisha state transport authority (STA) "DEESHA" Report, 2023
d. Odisha STA, "Enforcement" Report, 2023

2. For this case study, the average exchange rate for 2023 (until July 2023), where $1=Rs. 82.2 has been considered

As of 21st April 2023, 2022 data is only available for the first three quarters of the year:

Table 12.1: Road crashes for the first quarter of 2021 and 2022 in Odisha			
Quarter	2021	2022	% change
Q1	3230	2895	-10.37%
Q2	2331	3134	+34.45%
Q3	2481	2663	+7.34%

Table 12.2: Road crash deaths for the first quarter of 2021 and 2022 in Odisha			
Quarter	2021	2022	% change
Q1	1470	1359	-7.55%
Q2	1085	1490	+37.33%
Q3	1132	1134	+0.18%

Note: The Odisha Transport Department reported a dip in road crashes and deaths by 7.56% and 6.24% respectively in the second quarter of 2023, in comparison with the second quarter of 2022 (Orissa Post 2023).

12.1 ABOUT THE PROJECT

Odisha, in the eastern part of India, is the 9th largest State in the country in terms of geographical area (155 thousand sq. km.), and the 11th largest State in terms of population (41.9 million , as per the 2011 Census). In 2019-20, the State had a total road length of 2,69,799 km. About 10 million vehicles are registered in Odisha, as of October 2022 (Odisha Lead Agency 2023).

The Government of Odisha is currently undertaking concerted measures to mitigate road crashes and deaths, continuously improve the status of road safety, and ensure safe travel for all road users in the State. The Government is leveraging new technologies to improve road engineering, vehicle safety, and driver assistance to avoid crashes and enhance the range and effectiveness of speed enforcement.

12.2 BACKGROUND

Odisha is among the top 15 States with the highest road crash deaths in the country, with over 3% of India's total deaths in 2021. In 2021, a total of 10,984 road crashes were registered in Odisha, which claimed 5,081 lives (MoRTH 2022). The increase in vehicular population, unpredictable human behavior, defective road design, and deficiencies in vehicle design are some of the key factors contributing to road crashes in the State (Odisha Lead Agency 2023).

In an attempt to achieve the Sustainable Development Goals (SDG) 3.6 (United Nations 2023), the Odisha State government initiated various road safety interventions across the 4 E's of road safety - Engineering, Enforcement, Emergency Care, and Education. These have been discussed in detail in the sections below:

Decision-Making Tool:
Data from State Crime Records Bureau

Enabler:
Directions from meetings of Road Safety Fund Management Committee, June 9th, 2022; Government orders for implementation of Engineering and Enforcement measures

Validation Mechanism:
Challan data

12.3 INTERVENTIONS

To obtain more details on the implementation of good practices across the 4 E's of road safety, a questionnaire was sent to the Commerce and Transport Department, Government of Odisha. Shri Sanjay Kumar Biswal, erstwhile Joint Commissioner of Transport, Road Safety, Odisha, responded to this questionnaire.

12.3.1 Data Analysis

The following data repositories and tools are referred to for analyzing the on-ground scenario:

- Road Crash data collated by the Crime Branch, Odisha State Crime Records Bureau (SCRB). The district-wise data is collected by each District Crime Records Bureau and is collated by the SCRB (National Crime Records Bureau 2022).
- Following the Supreme Court Committee on Road Safety's directions, Forensic Road Crash Investigations are conducted for mass fatality road crashes by an expert team in the State. The team comprises a police investigation officer, a designated engineer of the concerned road-owning authority, and a technical officer of the regional transport office (The Times of India 2022). The investigation also incorporates feedback from the first responders at the crash site. The remedial measures are shared with the concerned authorities for implementation. Expert-led investigations have helped to analyze the multitude of factors behind the crash rather than those stated by bystanders.
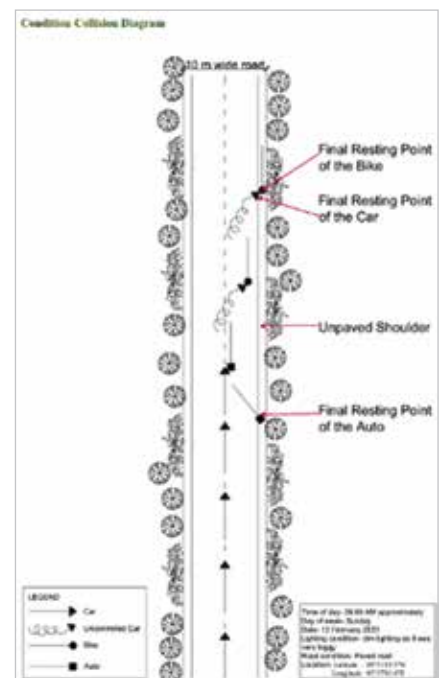

Figure 12.1: Condition Collection Diagram Used in a Forensic Crash Investigation (Source: Puri Crash Investigation Report)

- Enforcement Data is also collected through electronic means (e-Challan). With the introduction of Intelligent Traffic Management Systems (ITMS) under the Driving Electronic Enforcement to Save HumAn lives (DEESHA) project, which has been introduced on certain stretches, challan data is electronically collected. The National Highways Authority of India (NHAI), Government of India has also introduced toll plazas that collect data on vehicle flow.

- Road Safety Audits: Audits of repeated blackspots (500 meter stretch) that witnessed multiple road crashes and deaths were conducted by an expert committee on eight National Highways, and three State Highways between August 24, 2021 and September 20, 2021. The recommended rectifications were shared with the concerned departments for implementation on a priority basis. Additionally, third-party audits of road signages and markings were conducted for 3000 km of the most vulnerable roads of the State (including State Highways and National Highways), and the recommendations are being shared with the concerned agencies for necessary action. An additional 5000 km road audit is currently in progress (Transport Department 2023).

12.3.2 Engineering

- Implementation of Zero Fatality Corridors (ZFCs) - As of 21st April 2023, ZFC has been implemented on NH-16, and five major blackspots have been rectified. This ongoing project commenced in February 2022. A Memorandum of Understanding (MoU) was signed with a road safety NGO, to significantly reduce the road crash deaths in Odisha in the next three years (i.e. between 2022 and 2025). This project includes the treatment of 100 vulnerable black spots in the State where the maximum number of road deaths have occurred in the last few years.

- Odisha's Lead Agency on Road Safety has audited 88 black spots on National Highways and State Highways in the State. Their recommendations have been shared with the Chief Engineer, Design Planning and Investigation and Roads (CE, DPI, and Roads), and the NHAI for rectification of black spots on a priority basis (Odisha Lead Agency 2023).

12.3.3 Enforcement Measures

- Driving Electronic Enforcement to Save HumAn Lives (DEESHA) Project: For more effective and efficient management and operation of road networks, the Transport Department of Odisha introduced the Driving Electronic Enforcement to Save HumAn Lives (DEESHA) Project. This project involves implementing Intelligent Traffic Management System (ITMS), which undertakes digital enforcement through Automated Number Plate Recognition (ANPR) (STA "Deesha" 2023).

Figure 12.2 Electronic enforcement measures installed under the DEESHA project (Source: STA "DEESHA" 2023)

The ITMS project has been implemented in Sundargarh, Berhampur, and Bhubaneswar so far. The command-and-control center for CCTV/ANPR is functional in these locations and the footage is monitored continuously for issuing e-challans to the traffic violators. Multiple cases of traffic violations are registered and violators are arrested within 24 hours through the ITMS system. This system can also help generate revenue for the government by detecting tax-defaulting vehicles, vehicles plying without insurance, without fitness certificates, and stolen vehicles. The ITMS is also being used for detecting vehicles involved in hit-and-run crashes. The DEESHA project has been implemented on a 140 Km stretch on National Highway NH-16 i.e. between Panikoili and Rameswar (Transport Department 2023).

- E-detection: Since 2022, all the 22 toll plazas under NHAI across the State have been equipped with e-detection systems to catch vehicles passing through the toll gate without fitness/insurance/permit/tax certificates. It also helps in identifying tax evasion cases, off-road, and stolen vehicles. After the detection of violations, e-Challans are issued automatically against the violators (Odisha Lead Agency 2023).

Table 12.3: Number of E-challans issued and fines generated by toll plazas in Odisha under NHAI (Source: STA "Enforcement" 2023)		
Year	No. of E-challans issued	Challan Fine generated
2021-2022	2,47,945	INR 412,393,064 (USD 5 million)
2022-2023	2,80,682	INR 373,745,093 (USD 4.5 million)

12.3.4 Education/Engagement (Transport Department 2023)

• Vahak program: About 21% of the fatal road crashes in the State involve Heavy Motor Vehicles. Most HMV drivers are neither formally trained nor properly tested before they start driving the vehicles on the road. In view of this, the lead agency on road safety in the State, the Odisha State Transport Authority launched a refresher training program 'Vahak' for Heavy Motor Vehicle (HMV) drivers of the State at HMV Driver's Training Institute, Chhatia, Jajpur. The training comprised a three-day residential program with modules of training on road safety, road behavior, fuel saving, familiarization to BS-VI engine for reducing emissions, first aid, HIV awareness, and a complete health check-up. Under this project, about 1532 drivers of the Odisha Mining Corporation were trained. The department aims to scale up and train around one lakh HMV drivers in the State.

• In a bid to improve the road safety scenario in Odisha, the Transport Department has initiated a State Level Road Safety and First Aid Training program for home guards and constables. In case of road crashes, often traffic personnel are the first responders. Such training is essential for traffic personnel on duty to attend to emergencies and save precious lives during the Golden Hour. The training aims at equipping participants to attend a panic-stricken crash victim and save his/her life. A total of 483 traffic personnel were trained in the first phase. This included 431 male and 53 female traffic personnel.

- To offer a scientific understanding of the crash investigation processes and their relevance, a State Level Crash Investigation Training program is being organized for officials of the Police and Transport department. Under this program, officers of the Police and Transport department are trained on how to provide authentic crash data which in turn facilitate the designing of policy-level interventions for reduction of road crashes. The training is being conducted at all the police range headquarters across Odisha. To date, a total of 642 officers have been trained across Odisha.

- The Transport department has initiated a capacity building and training program for road engineers of Odisha. About 200 engineers from the Works Department and NHAI have been trained under the program, which included insights on road safety, road safety audit, basic principles like Haddon's Matrix Safety System approach, Vision Zero, and emerging technologies in road designs and construction.

- National Road Safety Short Film Festival: Odisha recently organized National Road Safety Short Film Festival, 2022 a first-of-its-kind event in the country. There was an overwhelming response to the festival. A total of 230 entries were received in 6 languages from 8 States. The 42 shortlisted films were screened at a local multiplex in Rourkela and Town Hall in Puri. The winners were felicitated by Dr. Justice S. Muralidhar, Hon'ble Chief Justice, Orissa High Court.

12.3.5 Emergency Medical Care

- 'Rakshak' First Responder's Training program: Initiated on November 10, 2021, Rakshak is a road safety State-level training program wherein 30,000 volunteers staying or working at eateries and different business establishments and police personnel are being trained as First Responders for road crash victims. As of now, a total of 11,389 First responders have been trained with a vision to train another 20,000 by the end of May 2023 (Transport Department 2023).

- Establishing Trauma Care Facilities (TCFs): The Odisha government plans to establish a trauma care facility in each district as well as in every 50 km distance along National Highways passing in the State. As of April 2023, 33 TCFs have been identified and notified, one in each district, and 55 TCFs are identified and notified (Level ll) along the National Highways passing through the State. All the 88 TCFs are functioning in integration with existing health facilities of the District Headquarter Hospital (DHH), Sub-Divisional Hospital (SDH), and Community Health Centers (CHC). Further, a gap analysis of 27 TCF has been completed with regard to equipment (Odisha Government 2023).

- Reward for Good Samaritans: In January 2018, Odisha Government notified its State Policy for the Protection of Good Samaritans (CTD 2018). Under the Policy, Good Samaritans are eligible for a cash reward of Rs. 2000 (The New Indian Express 2022). The Central Government introduced a scheme for rewarding good Samaritans with a sum of Rs. 5000. Post the center's scheme, in Odisha, Good Samaritans are eligible to avail rewards under both the center and State scheme and receive a total of Rs. 7000 (Odisha Bytes 2021).

- Cashless Treatment Scheme: In Odisha, people suffering trauma due to road crashes are eligible for receiving cashless treatment within the first 48 hours post-crash occurrence under the Free Treatment for Trauma Fund (FTTF) (Odisha Government 2023).

12.4 TEAM STRUCTURE AND STAKEHOLDERS
- Transport Department officials
- Road Audit Experts
- Police Department
- National Highways Authority of India,
- Private agencies such as Center for Research and Professional Training and Services (CRAPTS), and Translink
- Financial support from institutions such as ICICI Lombard (Transport Department 2023)

12.5 PROJECT FUNDING (TRANSPORT DEPARTMENT 2023)
The initiatives undertaken in Odisha were funded by the State government and CSR funds.
The cost of the initiatives undertaken were as follows:
- Rakshak - INR 7 million (approximately USD 85,158)
- Vahak - INR 5 million (approximately USD 60,827)
- Crash Investigation - INR 4 million (approximately USD 48,661)
- Road Engineers Training - INR 2.7 million (approximately USD 32,847)
- Road Safety Training for Traffic Constables and Home Guard- INR 2.1 million (approximately USD 25,547)
- National Road Safety Short Film Festival - INR 2.7 million (approximately USD 32,847)
- Communication Cell- INR 6 million (approximately USD 72,993)
- Audit of repeated blackspots by an expert team - INR 200,000 (approximately USD 2,433)

- Third-party audit of road signages and markings for 3000 km of road stretch - INR 9 million (approximately USD 109 thousand)
- DEESHA - INR 180 million (approximately USD 2.19 million)
- Highway Patrolling - INR 100 million (approximately USD 1.2 million)

Total= INR 318.7 million (approximately USD 3.9 million).

This total funding included measures deployed under the four main road safety pillars viz. road engineering, police enforcement, emergency medical care, and road safety education and awareness.

12.6 REPLICABLE PRACTICES

- **Enhance the functioning of Trauma Care Facilities**: Identification and gap analysis of major trauma care facilities in each district of a State can complement existing healthcare facilities. The 88 TCFs identified in the State of Odisha are functioning in integration with existing health facilities such as the District Headquarters Hospital (DHH), Sub-Divisional Hospital (SDH), and Community Health Centers (CHC). Further, a gap analysis of 27 TCF has been completed with regard to equipment. The exercise enhanced the network of medical care facilities and documents their respective capacities and limitations. Therefore, such identification should be replicated at a national scale to ensure that all Indians have information on nearby trauma care centers, and access to timely trauma care.

- **Enforcement through ITMS and targeted policies:** Proactive enforcement through Intelligent Traffic Management Systems, Automated Number Plate Recognition (ANPR), special enforcement drives, and highway patrolling can effectively

identify and book highway traffic rule violations. The ITMS project, implemented in 3 districts in Odisha and on NH-16 has been shown to swiftly identify and catch traffic rule violations such as speeding, hit-and-run, and driving unfit and stolen vehicles. Special enforcement drives focusing on the Odisha school bus policy in addition to booking drunk driving and helmet violations have been effective on the State level. Therefore, these measures should be scaled up to all States in the country to augment the enforcement capacity.

12.7 KEY LEARNINGS/LESSONS LEARNED

- **Smooth Coordination between Planning and Implementation agencies:** According to the questionnaire response from the Odisha Transport Department, "There was a lack of proper implementation of the suggestive measures recommended by the expert team on the ground by the concerned authorities". Therefore, there needs to be a solid communication between the planning and implementing agencies to achieve smooth and proper implementation of road safety measures. As many of Odisha's road safety projects are still ongoing, bridging the gap in understanding is being addressed.

- **Development of public-private partnership:** The Odisha government had observed a lack of interest among private companies in sponsoring drivers to enroll under the VAHAK program. Private agencies need to be more engaged in road safety to complement the State government's efforts to combat the rising number of road crashes and deaths in the State. The Odisha Government has recently partnered with non-government organizations through MoUs to augment the State's road safety. Through these partnerships, the Odisha government plans to augment its engagement with private companies to enroll their employees in the training programs.

Case Study 13:
TAMIL NADU

State Government Road Safety Initiatives

The State of Tamil Nadu witnessed 17,918 deaths in 2017, which increased to 18,392 in 2018. Interventions across the 4E's were implemented in the State which led to a 2.8% reduction in deaths in the State between 2018 and 2022. Multiple stakeholders are involved in improving Tamil Nadu's road safety such as the Transport, Police, and Health departments.

1 | **KEY DATES:**
a. TAMIL NADU ACCIDENT & EMERGENCY CARE INITIATIVE (TAEI) WAS IMPLEMENTED ON JUNE 22, 2017 (STF 2023)
b. INNUYIR KAPPOM THITTAM: NAMMAI KAKKUM-48 SCHEME WAS INTRODUCED ON NOVEMBER 18, 2021 (HEALTH AND FAMILY WELFARE DEPARTMENT 2022)
c. ROAD SAFETY SPECIAL TASK FORCE: CONSTITUTED ON MARCH 15, 2022 (TRANSPORT DEPARTMENT 2022) THE PROJECT IS ONGOING

2 | **AREA COVERED: STATE-WIDE PRACTICE**

3 | **IMPACT: 2.8% REDUCTION IN DEATHS BETWEEN 2018 AND 2022**

4 | **SCOPE OF REPLICATION: THE PROJECT CAN BE IMPLEMENTED IN RELATIVELY HIGH-CAPACITY STATES THAT WISH TO AUGMENT THEIR INSTITUTIONAL CAPACITIES. THIS COULD BE DONE THROUGH THE ESTABLISHMENT OF GROUPS OR COMMITTEES TO OVERSEE PARTICULAR MATTERS PERTAINING TO ROAD SAFETY, PARTICULARLY IN THE REALM OF EMERGENCY CARE**

Road Crash Deaths - Tamil Nadu
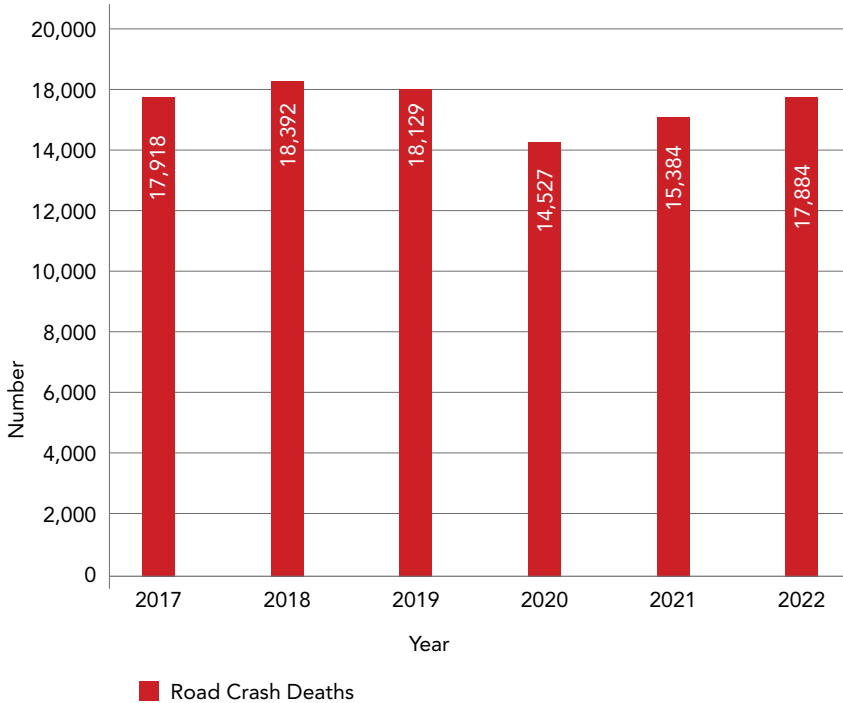
Graph 13.1: Road crash deaths in Tamil Nadu vs Year (2017-2022)
(Source: Data from the Special Task Force, Tamil Nadu)

1. Documents verified:
a. IDI with Dr. S.M. Thurai, TAEI, 2023
b. STF-RS Presentation, 2023
c. IDI with Mr. Vinit Dev Wankhede, erstwhile Additional Director General of Police and Chairperson, Special Task Force on Road
   Safety (STF–RS), 2023
d. Consultancy Services for Road Safety Management: Report on Road Safety Policy of Govt. Of Tamil Nadu, ECORYS, 2019
e. Final Report on Management Review of the Road Accident Data Management System, ECORYS, 2019

2. For this case study, the average exchange rate for 2023 (until July 2023), where $1=Rs. 82.2 has been considered

Impact specific to TAEI:

- Percentage increase in the number of patients that reached the hospital from the scene: 36.2% in Krishnagiri, 37.2% in Kancheepuram, 31.2% in Villupuram and 24.1% in Vellore.
- Percentage reduction in response times: 16.6% (2 minutes, 45 seconds) in Krishnagiri, 17.5% (3 minutes, 27 seconds) in Kancheepuram, 8.44% (1 minutes, 18 seconds) in Villupuram and 5.38% (48 seconds) in Vellore.
- Percentage reduction in trauma deaths: 5% from 8.27% in January 2018 to 3.28% in August 2018 (Ahamed 2019).

In the news: Chennai witnessed a three-year low in road crash deaths between January to June 2023 (The New Indian Express 2023). The data were compared for the period January 1st-June 20th for the years 2021, 2022, and 2023. In 2023, the city witnessed a 19.7% decline in road crash deaths since 2021.

13.1 ABOUT THE PROJECT

A coastal State situated in Southern India, Tamil Nadu (TN) is one of the major economic hubs in India. Road transport is a vital component supporting the State's economic activities (World Bank ICR 2022) and the incidence of road crashes also remains high in the State. To reduce road crash deaths, the Tamil Nadu government initiated several measures, including the Tamil Nadu Accident and Emergency Care Initiative (TAEI), a Special Task Force on Road Safety, and the Nammai Kakkum-48 Scheme. As a result, Tamil Nadu witnessed a marginal decline in road crash deaths between 2019 and 2022, when the road length in the State increased by 7% (STF 2023). The concerted efforts have helped create a robust evidence-based State-wide blueprint for tackling the issue of road safety.

13.2 BACKGROUND

Before the introduction of the State government initiatives, Tamil Nadu registered 17,918 deaths in 2017, translating to 2 deaths every hour (STF 2023). The Government of Tamil Nadu recognized road safety as a major public health concern that needed to be addressed urgently and adopted a safe system approach, with a target to reduce road crashes and deaths by 20% by 2025 (ECORYS 2019).

13.3 INTERVENTIONS

13.3.1 Road Safety Management
a. Special Task Force On Road Safety
The Transport Department, Government of Tamil Nadu constituted the Special Task Force (STF) on Road Safety on March 15, 2022, to assess and prevent road crashes, injuries, and deaths in Tamil Nadu (G.O. (Ms). No 146) (TN Home Dept 2022). The Task Force had to identify long-term and short-term road safety goals for the State, monitor the implementation of road safety interventions, and prepare the groundwork for the eventual establishment of a State Road Safety Authority. The STF is empowered to take the help of academic institutions such as IIT Madras and State agencies such as the Tamil Nadu e-Governance Agency for data analytics, field surveys, and the development of software applications (TN Home Dept 2022). The STF is also empowered to hire project management consultants to improve the efficiency of road safety projects in the State.

As per an In-Depth Interview (IDI) conducted with Mr. Vinit Dev Wankhede, erstwhile Additional Director General of Police and Chairperson, Special Task Force on Road Safety (STF–RS), in March 2023, the following information was obtained:

Decision-Making Tools:
iRAD (data analytical tool), FIR Data from the police (data tool)

Enabler:
Implementation of the Tamil Nadu Accident & Emergency Care Initiative vide G.O. (Ms). No 231; G.O. (Ms). No 146: Constitution of Special Task Force; G.O.(Ms) No.46 Nammai Kakkum 48

Validation Mechanism:
Analysis of road crash data

- The STF found that 85% of road crash deaths in the State were two-wheeler riders and pedestrians. However, the helmet-wearing rates were found to be low in Tamil Nadu due to the hot and humid weather, aesthetic concerns of riders, and resistance to mandatory helmet use. STF also identified drunk driving as a major cause of road crash deaths (STF 2023). The STF emphasized the necessity of decentralization of 'Short Term Road Engineering works' so that road furniture works get implemented faster.

- The STF determined that safer roads made it less likely for crashes to be fatal. Therefore, engineering issues need to be focused on to improve the level of safety built into the roads. The following actions were taken by the STF with regard to road engineering (STF 2023):

Figure 13.1: Bollards installed on the Kallakurichi Bypass Road to separate the opposing flow of traffic

- Head-on crashes were common on certain sections of bypass roads under the National Highways of India (NHAI) in the State. For instance, there was a two-lane section on the Kallakurichi bypass which expanded into four lanes on both approaches. Therefore, STF suggested the installation of bollards on this and 7 other bypass roads to divide the opposing streams of traffic which directly led to a reduction in the number of crashes in general and fatal crashes in particular.

- A memo issued by STF regarding unauthorized median openings on National Highways dated June 14, 2022, led to relevant corrective action in Trichy, Madurai, and Villupuram districts.

- STF wrote a letter to the NHAI dated June 16, 2022, proposing solutions to improve intersections such as better road markings, speed breakers, road studs, and signboards. Letters were also sent to the Tamil Nadu Water Supply and Drainage Board (TWAD Board) & Tamil Nadu Generation and Distribution Corporation (TANGEDCO) regarding civil works on highways and trees on shoulders (STF 2023). As a result, instead of a single signboard depicting a construction zone, cones, and signs were placed at a further distance to allow drivers to adjust directions (STF 2023).

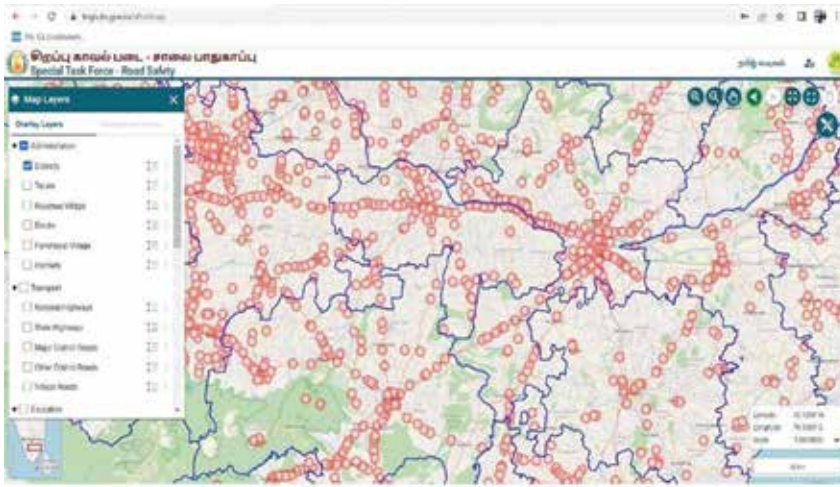*Figure 13.2: A flyover in Coimbatore lacking superelevation at curves*

Figure 13.3: Snapshot of the TNGIS portal documenting road crash hotspots in Tamil Nadu

◆ Local inspectors and officials aware of the causes of road crashes and solutions to prevent them were not included in the process. Thus, their knowledge of ground truths was collected via the Field Survey mobile application. Since the latitude and longitude data (also called lat-long data) was also found to be faulty, each police station was additionally tasked with correcting the same. The data was then mapped on the TNGIS portal where locations of road crash hotspots and gaps in medians were plotted accurately for the entire State. As of date, road crash data from 2019 to March 2022, 4051 Hotspots identified by Police Station Level Field Survey, and 380 unauthorized median openings have been plotted in the Portal (STF 2023).

• The STF published handbooks on "Road Accident Prevention Solutions" for both general and urban-specific contexts. The STF also did a road crash data re-verification exercise for the years 2017-2020 (STF 2023).

b. Data Analysis

i. Data Management

- Trauma registry: The Trauma Registry that has been established under TAEI collates data on trauma, burns, poisoning, and strokes, to name a few daily. The trauma registry is IT-based and consists of features such as triangulation of pre-hospital data, real-time patient tracking, an automated scoring system for injuries, and pre-hospital notifications, to name a few (Subramanian 2023). Opposed to standalone registries such as hospital and public health registries, the Tamil Nadu trauma registry was a first-of-its-kind practice in India with respect to data triangulation. Data served as the first starting point in the Tamil Nadu Accident and Emergency Care Initiative (TAEI) program. Initially, the State lacked a hospital record having a count of Road Trauma Injuries (RTI). To create a trauma registry, an application was used to collect the aggregate data to calculate the count of road crashes. Then, in September 2021, a robust IT-based trauma registry was created in Tamil Nadu which included pre-hospital data, in-hospital data, and rehabilitation data for trauma cases and other types of medical emergencies. A patient was tracked from when they were picked up by an ambulance, in transit, and when dropped at the hospital. A patient ID was generated which was used to track the patient even when they were referred to other hospitals. For road trauma cases, tracking starts from the time a patient met with a road crash till the rehabilitation stage-a special feature of TN's trauma registry (TAEI 2023).

- One of the interventions under the TNRSP-I is the Tamil Nadu Road Accident Database Management System (TNRADMS) which is now iRAD/e-DAR. It was introduced by the government of Tamil Nadu in partnership with the World Bank to collect and analyze essential data that would help identify various steps required for improving road safety. The RADMS was developed by the Indian Institute of Technology Madras (IIT Madras) Center of Excellence for Road Safety (CoERS). The

major stakeholders of TNRADMS were the Police, Transport, and Highways departments (ECORYS RADMS 2019, 6). The practice later inspired the Union government to scale the system to all States and UTs in India (iRAD/e-DAR 2023).

• iRAD/e-DAR can be used for scientific analysis specific to Road Safety Management. The application is fully web-based and can facilitate an end-to-end crash data management system. It is equipped with built-in intelligent analysis and road safety program management functions. iRAD/e-DAR is also backed by a powerful Geographical Information System (GIS) engine that supports multiple GIS standards (ECORYS RADMS 2019).

ii. Forensic Crash Investigation:

Forensic crash investigations were conducted to assess the causes of mass fatality crashes. Crash investigation reports were prepared for mass fatality crashes in the districts Perambalur, Vellore, Thirupur, Salem, and Ulundurpettai (STF 2023). The factors were categorized into human, vehicular, and infrastructural factors, and then added to the "Root Cause Analysis Matrix," which further categorizes the factors into pre-crash, crash, and post-crash factors.
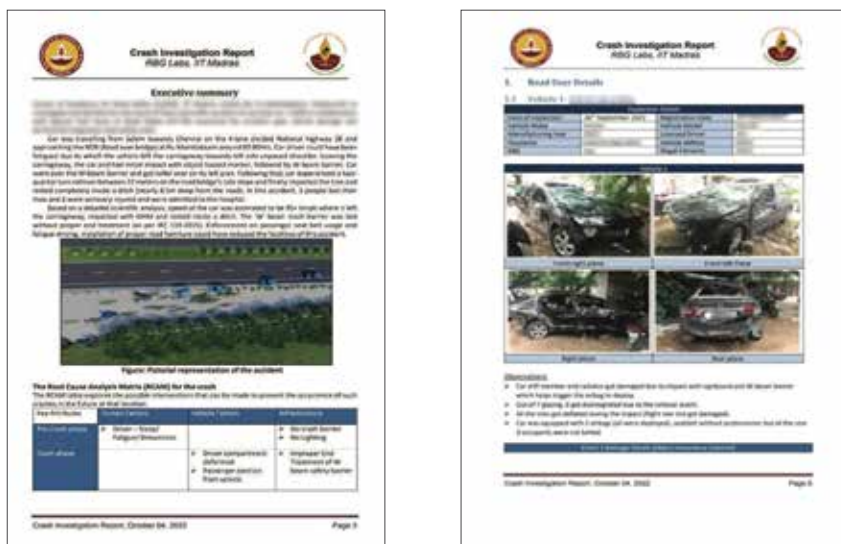

Figure 13.4: Forensic Crash Investigation (Source: STF 2023)

c. Tamil Nadu Road Safety Fund:

On October 22nd, 2022, the Government of Tamil Nadu vide G.O. Ms. No. 763, Home (Transport-V), introduced the "The Tamil Nadu Non-Lapsable Road Safety Fund Rules, 2022." These rules were created for the smooth and rapid fund deployment of road safety funds by minimizing delays and facilitating innovative interventions (Tamil Nadu Government Gazette 2022). The rules included the constitution of the fund, its administration, and the procedure to allocate the fund.

13.3.2 Engineering

- The Highways Department of Tamil Nadu implemented over 5000 road engineering interventions including installation of crash barriers. The Department also committed to conscious planning to ensure safe road design and infrastructure (ECORYS 2019).

- An Expert Committee was constituted on February 20, 2018 (Highways and Minor Ports Department 2018) as per the guidelines of MoRTH for recommending Road Safety proposals in the State roads under the Central Road Fund (Ministry of Road Transport and Highway 2017). Three academic experts in Road Safety from the Indian Institute of Technology (IIT), the National Institute of Technology (NIT), and Anna University were selected as members of the expert committee (ECORYS 2019).

- The revisions and amendments to the relevant codes related to design, construction, and planning are being updated by the State government in the design procedures as and when they are brought out by IRC (Highways and Minor Ports Department 2018).

13.3.3 EMERGENCY MEDICAL CARE

a. Tamil Nadu Accident and Emergency Initiative

The Tamil Nadu Accident and Emergency Care Initiative (TAEI) is a unique trauma care program, introduced to strengthen emergency care systems in the State. The program helped Tamil Nadu reduce its road crash deaths by 1.4%. This dip in deaths was measured post-COVID-19 restrictions were lifted in the State. 2019 was considered the baseline year and 2022 was considered the endline. This reduction was achieved despite a 2.5% increase in the number of road crashes in the same period (TAEI 2023).

In 2017, the then Mission Director of the National Health Mission (NHM) in Tamil Nadu, Dr. Darez Ahamed proposed the creation of TAEI with the mission director as the ex-officio Commissioner of Trauma Care, both of which were accorded to by the government vide notification G.O. (Ms) No. 231 dated June 22, 2017 (Ahamed 2019). Next, the Department of Health, Tamil Nadu signed a Memorandum of Understanding (MoU) with the following stakeholders for the initiation of the TAEI in the State:

- Monash University, Australia, where they designed the pilot program,
- All India Institute of Medical Sciences (AIIMS), Delhi, where the pilot program had been running successfully (The New Indian Express 2017).

Initially, TAEI involved a hub-and-spoke model, with 'spokes' providing first care, and 'hubs' providing "definitive" care (TAEI Online 2023). This classification was based on a feasibility analysis that mapped the hubs to their spokes on the basis of them having "assured referral linkages". The same allowed trauma care centers to be designated as Level 1, Level 2 and Level 3 (Level 1 centers providing the highest level of care), as per Tamil Nadu's Trauma Care Policy (TNHFW 2018).

The following interventions were implemented as part of this initiative:

- Under TAEI, emergency services are provided throughout the State, in hilly regions or plains with a monitoring system both at the headquarters and medical college level (TAEI 2023).

- Data such as the number of pre-arrival intimations received by staff nurses in the emergency department or the time taken to reach the medical college hospital are monitored (TAEI 2023).

- Ambulances were allocated to road crash hotspots, each of a radius of four square kilometers, identified by a Geographic Information System (GIS) mapping exercise (Ahamed 2019).

- A global position transmitter application of the 108 ambulance service gathered latitudinal and longitudinal information of the caller's location, and a pilot navigation application was employed to reach the scene of the crash (Ahamed 2019).

- In the ambulance, cardiopulmonary resuscitation (CPR), as well as endotracheal intubation, is done. Information about the patient's condition before their arrival is also sought to better prepare the receiving team. TAEI centers are intimated in advance to facilitate quick reception of the patient at the special resuscitation bays (TAEI 2023).

- Neurosurgery or other specialties are alerted to quickly receive emergency cases in the ambulance bay. Then, the human resources are mobilized to resuscitate the patient. Depending on the severity of the injury, the patient is triaged into codes Red (most severe), Yellow, and Green.

- In the red zone, attempts are made to stabilize the patient and to decide the facility needed for the patient on a priority basis. A particular specialist takes over and manages a case accordingly. All the patients who are suffering from a medical emergency are treated in an operation theater in the emergency department. The human resource is also strengthened to receive and manage multiple cases at a particular time.

- The case is monitored by the hospital administration with the help of pre-arrival/pre-intimation number, receiving time, time the patient is admitted, the number of emergency surgeries per day, etc. The daily performance of the emergency department is also reviewed. Moreover, every month, a coordination committee meeting is held with ambulance drivers, emergency technicians, the nodal officers of the emergency department, the HoD, the faculty of emergency department staff, nurses, etc to review grievances regarding lacunae in transport and management of cases. Feedback from case studies helps reinforce and improve the system to further minimize road crash deaths (TAEI 2023).

b. Innuyir Kappom Thittam Nammai Kakkum-48 Scheme

Taking the burden of road crash deaths and injuries as well as the exorbitant out-of-pocket expenditure incurred by families into consideration, in 2021, the Chief Minister of Tamil Nadu, Mr M.K. Stalin inaugurated the Nammai Kakkum 48 (NK-48) scheme under the Innuyir Kappom Thittam (IKT) (The Hindu 2021).

The scheme was launched to ensure that all road crash victims have access to emergency medical care in the first 48 hours following the trauma. The scheme also focuses on reducing delays due to the denial of treatment and multiple inter-facility transfers, to help reduce mortality and morbidity. Under this scheme:

i.   683 hospitals (448 private and 235 government hospitals) are empaneled at crash-prone stretches. The selection of these hospitals was done according to the top 500 crash grid and time of transport from the road crash site to the nearest medical facility.

ii. A Trauma Care plan has been formulated for each district of Tamil Nadu. In these plans, the ambulances are mapped to the nearest empaneled hospital. This is done to reduce time delays and prevent deaths within the Golden Hour.

iii. There are 81 designated treatment procedures that cost up to INR 100,000 (USD 1,216) per individual for which cashless treatment is provided to all victims, irrespective of their insurance coverage.

iv. The scheme covers all road crash victims who are domiciled in Tamil Nadu and other States and Foreign Nationals who witness a road crash within the State's boundary. 683 hospitals (448 private and 235 government hospitals) have been empaneled on highways (Health and Family Welfare Department 2022) based on the top 500 crash grid and taking into account the time of transport from the road crash site to the nearest medical facility.

The operational guidelines for the scheme are as follows:

i.   Road crash victims can receive the first 48-hour treatment on a cashless basis in the empaneled hospitals through approved procedures.

ii. If the victim remains unstable even after 48 hours of treatment, the victim continues to receive free-of-cost treatment at a Government Hospital. In case the victim is admitted to an empaneled private hospital, they will be treated according to their insurance coverage. If the patient is covered under the Chief Minister's Insurance Scheme, the treatment continues at the same private hospital. If not covered by the scheme, they are stabilized and transferred to a government hospital. The patient may also pay for their treatment or use private health insurance (STF Response 2023).

From December 18, 2021, to March 23, 2023, a total of 1,51,569 patients benefited through this scheme in government (1,37,611) and private (13,958) hospitals (STF Response 2023).

13.4 TEAM STRUCTURE AND STAKEHOLDERS

13.4.1 Team Structure Of Special Task Force

The Special Task Force is headed by the Additional Director General Police, State Crime Records Bureau who acts as the Chairperson. While the Joint Transport Commissioner (Road Safety) acts as the Member Secretary, the Mission Director of the National Health Mission, the Chief Engineer of the Highways Department, and the Secretary (Expenditure) of the Finance Department serve as members (TN Home Dept 2022).

13.4.2 Team Structure of TAEI:

TAEI is operated by the State TAEI Governance Committee and the District Program Unit. The State TAEI Governance Committee has numerous high-ranked stakeholders such as the Principal Secretary, Health and Family Welfare Department (as the Chairperson and the Mission Director, National Health Mission/ Commissioner of Trauma Care as Member Secretary). Other committee members include:

- Director of Medical Education
- Director of Medical and Rural Health Services
- Director of Public Health and Preventive Medicine, Commissioner of Trauma Care (PD- TNHSP)
- MD, Tamil Nadu Medical Supplies Corporation Limited (TNMSCL), Director of Trauma Care (Level-1 facility at Chennai)
- State Head of the 108 Ambulance services
- Head, Chief Minister's Comprehensive Health Insurance Scheme (CMCHIS)
- President, Indian Medical Association (IMA)
- Private Hospitals Network
- Representation from the Police, Road Transport, and Highways Department

The District Program Unit is chaired by the District Collector, District Trauma Care Nodal Officer (Joint Director rank), and Hospital Trauma Care Nodal Officer (HTNO) of respective Trauma Care Centers (Ahamed 2019).

13.4.3 Stakeholders in iRAD/e-DAR:

Police Department, Transport Department (Motor Vehicles Inspector), Highways Department of States and NHAI, and Health Department (ECORYS 2019)

13.5 PROJECT FUNDING

While the overall funding of the various road safety initiatives is difficult to estimate as it is implemented by various State departments. However, the funding for some of the project elements is as follows:

- From 2017 to 2022, TAEI was jointly funded by the Tamil Nadu State government and the National Health Mission in a ratio of 60-40% (TAEI 2023). It was implemented with an initial cost of INR 570 million (USD 6.9 million) to set up nine Level II and Level III hospitals. The project is now self-sustaining (Health and Family Welfare Department, TN 2018).

- A total of INR 1.43 billion (USD 17.4 million) was incurred for the Innuyir Kappom Thittam Nammai Kakkum-48 Scheme till March 2023 (STF Response 2023).

- The TNRADMS was developed at a cost of INR 22 million (approximately USD 268 thousand) (World Bank 2011).

13.6 REPLICABLE PRACTICES

- **Involvement of High-Ranking Officials in Road Safety Bodies:** The institutional setup and operations under State road safety projects can greatly benefit from the leadership of high-level officials such as at the level of a Principal Secretary. This is evident through the institutional setup and operations of Tamil Nadu's bodies such as the Special Task Force, with the involvement of high-level stakeholders such as the Additional Director General Police, State Crime Records Bureau. Further, the TAEI has senior bureaucrats such as the Principal Secretary, Health and Family Welfare Department as its members. As major road safety interventions are implemented at the grassroots level, by having senior government officials involved in road safety bodies, the implementing agencies will also be accountable to the senior officials for road safety works. Tamil Nadu's road safety bodies can be used as an example for other States.

- **Involvement of Institutions and Experts in Road Safety Solutions:** Government can invest in the research, development, and implementation of road safety solutions in academic institutions. It has been demonstrated that encouragement and adoption of cutting-edge research can keep State governments ahead of the curve. Both TAEI and TNRADMS resulted from research supported by institutions such as the Indian Institute of Technology Madras (IIT Madras) Center of Excellence for Road Safety (CoERS), and were piloted successfully by the State government. While the former led to a reliable emergency care system throughout the State, the latter inspired the Union Government to scale the system across the country. The Union and State governments

can similarly sponsor research and development in medical and engineering institutes of national importance, and apply resulting products and findings to State government projects. Some initiatives by MoRTH such as iRAD/ e-DAR involved the prestigious IIT Madras for its development.

- **Improved data collection:** Establishing better data collection and management practices via the use of technology can allow State governments to accurately analyze the need/ effect of road safety policies and interventions. For example, the data collection system known as the TNRADMS (now iRAD/ e-DAR) allowed the government to avoid reliance on paper-based reports and effectively link the data from Police, Transport, and Highways departments. Also, the Tamil Nadu trauma registry facilitated the maintenance of consistent and comprehensive patient data. Other States can similarly adopt standardized registries for trauma cases and inter-department data on road crashes.

- **Road Safety Fund Rules:** As per the Supreme Court Committee on Road Safety directions in 2016, all States are required to create a Road Safety Fund for conducting road safety activities. However, there are reports of non-optimal utilization of the fund. For example, recent news has indicated that States such as Maharashtra have underutilized their road safety funds by a large margin (The Economic Times 2023). The Road Safety Fund Rules were introduced to ensure proper dissemination of funds under the Tamil Nadu Road Safety Fund. The rules include the constitution of the fund, its administration, and the procedure to allocate the fund. Similar rules should be introduced in other States to ensure efficient management of the road safety fund.

- **Hub-and-Spoke Model:** The TAEI involved a hub-and-spoke model, where spokes were centers where victims could receive first aid, and hubs were centers where the victim could receive more elaborate, or "definitive" care (TAEI Online 2023). This classification was based on a feasibility analysis that mapped the hubs to their spokes on the basis of them having "assured referral linkages". The same allowed trauma care centers to be designated as Level 1, Level 2 and Level 3 (Level 1 centers providing the highest level of care) (TNHFW 2018). Other States can also identify levels of trauma care centers on the basis of assured referral linkages.

13.7 KEY LEARNINGS/LESSONS LEARNED

- **Consideration of Community Opinions and Behavior:** The Special Task Force wanted to assess the reasons why truck drivers drive on the right-most lane of the road, despite it being illegal. The Special Task Force (STF) then noted that since service lanes, parking activities, and slow-moving traffic all use the left side of the road, truck drivers believed driving on the right lane was safer and preferred using it to drive uninterrupted. This led to other vehicles overtaking from the left of the truck instead of the right, which was a risky maneuver. The behavior of the truck drivers was thus a barrier to the STF's efforts toward augmenting road safety. The Special Task

Force reported that they are considering these factors and are looking at ways to address the issues reported by the truck drivers, as well as promoting targeted awareness generation against the current perception of truck drivers (STF 2023).

- **Emphasizing reduction in road crash injury burden:** Drunk driving was a significant cause of road crashes in Tamil Nadu. People who opted out of public transportation in a drunk state ended up being involved in a large number of road crashes. While defaulters were promptly pulled up by enforcement personnel, the underlying issues remained unaddressed. Therefore, to reorient focus back on road safety, the STF is considering removing quotas for the number of challans in favor of the goal of "reducing road crashes and deaths"(STF 2023).

Chapter VI:
Recommendations

Many common themes appear to be recurring in the good practices employed by different road safety agencies. The following chapter enlists some of these common themes and learnings for the stretches studied to put forth recommendations of the activities that can be undertaken to ensure safer stretches and, thereby, roads that provide the option for a more secure commute for all types of road users.

INSTITUTIONAL MECHANISM

1. **Strengthening of road safety institutions:** Road safety institutions should be bolstered through smooth stakeholder collaboration, multi-stakeholder government engagement and institutional strengthening plans. Efficient stakeholder collaboration can help in removing any disruptions in road safety management, and the coordination between State Road Safety Councils and District Road Safety Councils can lead to the setting up of additional working groups for focusing on key road safety projects consisting of internal and external members to improve safety. The involvement of senior officials in road safety agencies will ensure that not only will they be responsible during the planning stage but will also be responsible for monitoring the situation on-ground, thereby increasing the accountability of on-ground implementation. The institutional setup of agencies such as the Tamil Nadu Special Task Force and the Tamil Nadu Accident and Emergency Initiative can be used as a model for all States. The institutional strengthening plans, as was done in

Karnataka under the Karnataka State Highway Project II, should include elements such as asset management systems, the use of advanced-level equipment for quality control, building the capacity of human resources, environmental management, and checking adherence to the standards prescribed by the International Organization for Standardization, to name a few Finally, private funding through CSR can be utilized for road safety works.

2. **Focus of Corridor-Based interventions such as SCDP and ZFC:** The SCDPs and the ZFCs targeted stretches that witnessed a disproportionately high number of fatalities. The Mumbai-Pune Expressway, for example, witnessed approximately six times higher than the road crash deaths per km witnessed on the national highways in the country. By implementing road safety interventions across the 4 E's, the SCDP and ZFC have brought about as much as a 60% (NH-48 brought about a 61% reduction in deaths between 2018 and 2021) reduction in fatalities in the stretches. Such projects also have smaller budgets than State-based interventions. By scaling such interventions to all high-fatality corridors, over 56,000 lives can be saved in as few as 3 years with a relatively small investment. Further, based on an analysis of all corridor-based interventions, it is evident that dedicated funding has a catalytic impact on efficient implementation across the 4 E's.

3. **Efficient allocation of road safety funds:** As per the directions of the Supreme Court Committee on Road Safety in 2016, all States are required to form a dedicated non-lapsable road safety fund. While many States have established road safety funds (MoRTH 2023), there are issues with the disbursement of funds in some States. For example, Maharashtra has reported under-utilization of its road safety budget (The Economic Times, 2023). The budget allocation should be based on summary audits and a detailed analysis of road crashes through crash investigations, etc. Tamil Nadu released its Road Safety Fund

Rules in 2022, which specified the procedure for disbursement of the State road safety fund, a practice that may be replicated by other States.

4. **Comprehensive 360-degree audits and evidence-based interventions:** Road safety audits should not only consider engineering measures, but also enforcement, emergency care, and engagement measures as well. CVAs that have been conducted on stretches such as NH-48 and MPEW effectively identified road safety issues across the 4Es of road safety. Initiatives such as the CVA should be employed across the country's roads, especially in high-fatality zones. Through such audits, suitable road safety measures that will bring about a maximum reduction in deaths, crashes, and injuries will be adopted. In addition, States such as Uttar Pradesh have notified their own Statewide forensic crash investigation schemes under Section 135 of the Motor Vehicles Act, 1988. Such schemes should be adopted by all States, as they give a detailed analysis of all the causal factors for specific crashes. Further, one of the major issues with the current institutional setup for road safety is poor data collection. Road crash and enforcement data should be digitized and updated on a timely basis. With the introduction of iRAD/e-DAR nationwide, all stakeholders need to ensure that the data collection mechanism is smooth, efficient, and time-bound.

ENGINEERING

1. **Ensure Timely Engineering Audits:** Detailed engineering audits should take place on all roads in the country, at least annually. Such audits took place in most corridor-based interventions such as Belgaum-Yaragatti Highway, MPEW, and YEW. These are essential to identify the gaps in road engineering that can compromise the safety of all road users. Further, all corridor-based interventions included in this report involved detailed audits of the road engineering risk factors. These audits

checked the adherence of road infrastructure to the relevant codes, such as those of the Indian Roads Congress. Based on the findings of these audits, suitable changes were made to the design, construction, and maintenance of the road. Such audits are mandatory under rule 166 of the Central Motor Vehicles Rules, 1989 (Fourteenth Amendment), and thus, all the more would be replicated across the country, particularly at high-fatality corridors.

2. **Adequate infrastructure in High Fatality Zones:** Installation of crash barriers as per the IRC Codes (IRC:119-2015) across all high-fatality zones in high-speed corridors to reduce the impact of crashes that may take place due to causes such as losing control and veering off-lane, to name a few. From the report findings, it is evident that almost all corridor-based case studies included the installation of crash barriers as one of the primary engineering practices adopted.

3. **Installation of Adequate Signage:** Installation of appropriate signages was another practice that was common across engineering interventions. India currently needs more proper road signages. For example, from the audit at the Old Mumbai-Pune Highway, it was ascertained that there were absent signages at over 300 locations and incorrect signages at over 60 locations. These were later rectified. However, many stretches in India continue to have inadequate or improper signage. Therefore, appropriate signages should be installed based on relevant updated guidelines.

4. **Improve Road Visibility:** Enhanced road visibility is essential for safe driving. Road delineations and markings must be clear and visible to all road users. Reflectors should be provided in areas with low visibility or for night-time driving. Enhancing road visibility is an essential component of road safety, and it was one of the key engineering measures adopted across States as an essential good practice.

5. **Emphasize on High-Fatality Zones:** Blackspot rectification is a practice that is already widely adopted across India. However, the emphasis should not be only on rectifying the particular spot but also the nearby stretches. Instead of black "spots," high fatality "zones" should be remedied. This includes the area surrounding crash-prone spots. The Kerala Sabarimala Safe Zone is a project where the entire zone was made safer for all road users. Further, on the MPEW, high-fatality zones were considered for interventions.

6. **Implementation of Tactical Redesign of Intersections and Zones:** Tactical Redesign of intersections is a useful, affordable, and scalable solution for enhancing intersection safety for all road users, particularly vulnerable road users such as pedestrians and non-motorized transport users. It involves the deployment of soft temporary, and low-cost interventions such as paints, cones, and barricades to reallocate and redesign the road space to reduce pedestrian and NMT exposure to motorized traffic, and reduce the speeds at the intersection. The interventions can be tested out for a short duration, and based on the results of the trials, the best interventions can be identified for permanent redesign of the intersections. Such trials were conducted in Karla Phata of the Old Mumbai- Pune Highway, and the trial's findings are being considered for permanent intervention at the intersection.

7. **Emphasize Enhancing Pedestrian and School Zone Safety:** Dedicated road space should be provided to such users to minimize the interaction of pedestrians and Non-Motorized Transport (NMT) users with higher-speed motorized traffic. This should especially be done on roads with high levels of interaction of mixed traffic. For example, by providing dedicated road space to pedestrians and NMT through Tactical Urbanism on the Old Mumbai-Pune Highway, the exposure of pedestrians and NMT users to motorized traffic was reduced. Further, special emphasis should be placed

on enhancing road safety at school zones. Children often commute to school by walking or using bicycles, and are exposed to motorized traffic in school zones. To minimize this exposure, school zones should have dedicated road space for children. Further, speed-curbing measures such as speed bumps and "SCHOOL AHEAD" signs should be added to the school zone infrastructure to ensure lower speeds of motorized vehicles around the zone. Examples can be taken from the interventions made in Kerala's SCDP.

8. **Establish Rest Stops:** The establishment of dedicated rest stops and truck lay-byes can help reduce cases of fatigued driving. When drivers are fatigued, their reflex time significantly decreases, and their lack of concentration leads to violations such as speeding (European Union 2015). To prevent cases of fatigued driving, truck rest stops were established on the MPEW which contributed to 40% reduction in deaths on the expressway between 2016 and 2022. Therefore, truck lay-byes, and rest stops can prevent fatigued driving, hence augmenting the road safety of high-fatality stretches.

ENFORCEMENT

1. **Enhance Enforcement Capacity:** Enhancing capacity is one of the significant components of improving on-ground enforcement. For a country as populous as India, the police force is highly overburdened. Recent estimates suggest that the strength of the police force in India is 137 per lakh population, which is less than the standard recommended by the United Nations, i.e. 222 police per lakh population. (PRS India 2017). Therefore, there is a need to adopt measures to enhance the capacity of the police force in India. Enforcement capacity can be improved through the following actions:

a. **Adopt Measures for Electronic Monitoring and Enforcement:** There is a need to shift towards electronic monitoring and enforcement measures. Electronic enforcement can be used

to capture violations such as speeding, wrong-side driving, unsafe overtaking, and driving without safety devices, to name a few. In India, electronic monitoring and enforcement guidelines have been notified under Section 136A of the Motor Vehicles (Amendment) Act, 2019. Some of the good practices presented in the study have used electronic enforcement techniques. For example, in Tamil Nadu, speed-measuring radar guns were used for enforcing speed limits in some places. Further, there should be training programs to train the enforcement officials on operating devices for electronic monitoring and enforcement. Such training was conducted in Karnataka, where police personnel were introduced to the use of cameras meant for monitoring vehicle speed and enforcing speed limits. Electronic enforcement measures can be fully automated using Artificial Intelligence or can use a combination of manual and digital means. Electronic monitoring can be conducted through actions such as Vehicle Activated Speed Sign (VASS), which measures vehicle speeds in real-time as they pass through the stretch. These signs make drivers aware of their speeds and helps prevent speeding. Electronic enforcement can also be deployed to detect the absence of relevant permits. For example, in Odisha, since 2022, all the 22 toll plazas under NHAI across the State have been equipped with e-detection systems to catch vehicles passing through the toll gate without fitness/insurance/permit/tax certificates. Finally, the electronic enforcement measures should be integrated with a backend database to efficiently identify violators. For example, in Tamil Nadu, e-challans are issued through smart software integrated with VAHAN (national database of vehicle registrations) and SARATHI (national database of driving licenses) databases. Weighbridges can be installed for checking for overloading, as was done in the case of the Hyderabad-Bijapur Corridor.

b. **Deploy Smart Patrol Vehicles:** Smart Patrol Vehicles can improve the on-ground enforcement scenario. Such vehicles were deployed on stretches such as the MPEW, Renigunta-Kadapa stretch, and Old Mumbai-Pune Highway, to name a

few. These vehicles are beneficial on highways that often lack dedicated highway police forces, hence witnessing low levels of enforcement on-ground. At the Sabarimala Safe Zone, 15 Patrol teams of 45 officers were deployed from the Kerala Motor Vehicles Department with vehicles fitted with GPS, wireless, fire-extinguishers, and other safety devices. On the Hyderabad-Bijapur Corridor, the interceptor vehicles for the project were equipped with electronic enforcement measures such as laser speed guns and body-worn cameras. On the MPEW, interceptor vehicles were placed at High Fatality Zones for active, visible enforcement. Active patrolling through these vehicles helped prevent over 40,000 rear-end collisions on the MPEW.

2. **Adopt Intelligent Traffic Management System (ITMS):** ITMS is a measure for deploying smart enforcement techniques. This involves the deployment of electronic enforcement and monitoring measures that a Command and Control Center manages. For example, in Odisha, the ITMS project implemented in 3 districts and on NH-16, could swiftly identify and catch traffic rule violations such as speeding, hit-and-run, and vehicles that were unfit or stolen. The command-and-control center for CCTV/ANPR is functional in these locations, and the footage is monitored continuously for issuing e-challans to traffic violators. Multiple cases of traffic violations are registered, and many violators are arrested within 24 hours through the ITMS system. Additionally, command and control centers can also be established for management of patrol vehicles. For example, in Tamil Nadu, a State-level control room was activated that monitored the highway patrol vehicles.

3. **Conduct Specialized Enforcement Drives:** Enforcement Drives are an additional measure for temporarily enhancing enforcement on stretches. For example, a particular enforcement drive was conducted in Odisha, focusing on the Odisha school bus policy and for booking drunk driving and

helmet violations. Similarly in Kolkata, random checks were conducted jointly by the Transport and Police departments to check for overloading cases.

4. **Increase the Scope of Enforcement:** Transport and Police enforcement officials are mainly concerned with catching violations concerning the Motor Vehicles Act, 1988, and traffic violations. However, their duty should be extended to also capture violations of the Motor Transport Workers Act, 1961, which specifies that no transport worker should be permitted to drive for over eight hours continuously. For example, in Tamil Nadu, the maximum working hours of tourist/maxi cab drivers were enforced. Checks for fatigued driving and detecting violations under the Motor Transport Workers Act, 1961, should also be conducted.

EDUCATION/ ENGAGEMENT

1. **Training for Key Stakeholder Groups:** First responder training is potentially life-saving. Bystanders can render first aid to road crash victims, which will in turn increase their chances of survival. Training programs in Basic Trauma and Life Support (BTLS) techniques can play a significant role in administering bystander care. Such training programs have taken place in Odisha, MPEW, Old Mumbai-Pune Expressway, and Yamuna Expressway. In addition to first responder training, training should also be conducted for safe driving techniques among commercial vehicle drivers, truck drivers, and school bus drivers. For example, the 'Vahak' program of Odisha comprises refresher training for Heavy Motor Vehicle (HMV) drivers, including training modules on road safety, road behavior, and fuel saving, to name a few. Finally, specialized training for road safety key stakeholders can help with improving road safety management and enhance decision-making. For example, in Tamil Nadu, senior officials received formalized training in renowned institutions. Further, in Odisha, State Level Crash Investigation Training programs are being conducted

for police and transport officials to ensure that smooth and robust crash investigation techniques are being deployed. By upskilling the stakeholders in charge of road safety, the on-ground scenario can improve nationally.

2. **Conduct Targeted Risk Factor Campaigns:** Specific risk factor-focused safety campaigns should take place at a national scale. For example, on the MPEW, large-scale safety campaigns to prevent rear-end collisions were launched as part of the ZFC initiative on the MPEW. Campaigns focused on a particular intervention can help generate awareness among road users by specifying the reasons why it is a risk factor and providing robust information on how to prevent such risks. These campaigns can take place at the community level, i.e., at schools, places neighboring blackspots, etc., or through posters, audio messages at toll plazas, newspaper advertisements, and through radio and television.

EMERGENCY CARE

1. **Implement measures to enhance at-scene care for road crash victims:** According to the Law Commission of India's 201st report, 50% of the road crash deaths can be prevented if victims have access to timely medical care. At-scene care is crucial for the survival of road crash victims. The police are the most common first responders in a road crash. Thus, they can be trained in first aid, CPR, bleeding control, occupant extraction, and basic fire control, such as those conducted in the Old Mumbai-Pune Highway, MPEW, and YEW projects to render first aid to the victims. Further, to reach the crash site in a timely manner, particularly in areas with heavy traffic/footfall, such as the Sabarimala Safe Zone, police and emergency services can coordinate resources such as helplines and vehicles to locate injured crash victims.

2. **Strengthen Ambulance Response:** Ambulance positioning, procurement, upgradation, and allocation can be strategically done based on the gap assessment and historical road crash data. Technology such as GIS can help map road crash hotspots, as done by the TN Road Safety Task Force. As witnessed on the MPEW, ambulances can be upgraded and optimally positioned to reach the maximum number of patients and transport them to hospitals in the minimum possible time. Alternatively, ambulance deployment tools such as those used on the YEW can be used for the optimal positioning of ambulances so as to minimize response time. To complement and enhance the dispatch capacity, the police patrolling fleet can have a few multi-utility vehicles (MUVs) that can be utilized as emergency vehicles, such as those procured in the Kerala SCDP. These should be armed with first aid kits, extraction tools, and fire extinguishers to safely and quickly remove occupants from crashed vehicles. Further, accompanying paramedics should be duly trained, preferably by a Medical Director, in trauma intervention, field-to-facility telecommunication, and patient monitoring. They can convey preliminary patient information such as the nature and severity of the injury, the condition of the patient during the journey, and the estimated time of arrival to the receiving hospital so that the required resources can be mobilized in advance.

3. **Enhance decisive care for road crash victims:** Upon being presented to the receiving hospital, patients can be received in special resuscitation bays such as those created in priority TAEI-affiliated hospitals for stabilization, triage, and referral of patients. Their details should be registered on a separate road trauma registry following triage. As implemented in Tamil Nadu and other States, State health departments can develop a trauma registry for consistent and comprehensive maintenance of patient data. Further, States can institute a TAEI-like hub-and-spoke model that unifies and standardizes

the disparate operations of various healthcare facilities and ensures speedy referral for trauma patients. Such networks can include hospitals right from outpatient clinics at the primary level to specialized tertiary care centers, all working in tandem and can operate as per a standard State emergency care policy. Further, States can draft policies to cover the treatment of road crash victims financially. These can be framed on the lines of the policy in Tamil Nadu, wherein the Nammai Kakkum scheme provides for cashless treatment of road crash cases. Further, treatment of other cases can be continued at government hospitals after an initial period of stabilization.

4. **Quality improvement and trauma center verification:** Monitoring of trauma cases can be carried out both at the State health headquarters and the hospital administration levels using data on the number of pre-intimation calls, arrival time, time the patient is admitted, and the daily number of emergency surgeries. A monthly review of gaps in the handling of trauma cases can be carried out by a hospital coordination committee, similar to TAEI. This can include a review of feedback from ambulance drivers, emergency technicians, the nodal officers of the emergency department, the HoD, the faculty of emergency department staff, and nurses. A study of medical complications and preventable deaths can also be carried out. To identify gaps in trauma care delivery, facility mapping exercises and inventory of medical care facilities can be conducted via questionnaires and other instruments near crash-prone zones, such as what was done in the Karnataka SCDP. In addition, hospital and ambulance audits can be conducted to understand the gaps in capacity and training.

5. **Upgrade of existing facilities:** As per a mapping exercise, priority healthcare facilities can be identified and upgraded to handle trauma cases. Existing facilities near crash-prone roads can also be upgraded such as what was done in Tamil Nadu

SCDP, wherein a Center of Excellence in Trauma Care was set up. As seen in the Kerala SCDP, the upgradation of a facility can be done in two ways: infrastructure development and equipment procurement. While Level 3 facilities can benefit from equipment support, Level 1 and 2 facilities may require infrastructural support, including civil works, electrification, and air conditioning. In locations where no viable facilities can be identified for an upgrade, new trauma care centers can be established and equipped with new equipment and a fleet of ambulances.

In conclusion, the good practices presented in the study have demonstrated results through a notable reduction in road crashes and deaths. With road crash severity at a two-decade high in India (MoRTH 2022), these good practices need to be scaled up to transform the situation of road safety in the country. To achieve Sustainable Development Goal (SDG) 3.6, India needs to reduce road crashes and deaths by 50% by 2030 in the country. While this target may seem ambitious, the good practices in this study have shown promise in bringing a reduction in deaths. Certain interventions such as the ZFC project on the Old Mumbai-Pune Highway have already led to a reduction of over 60% in just four years. Therefore, by scaling up these interventions, the target laid down by SDG 3.6 can be achieved. The good practices presented in the study need to be codified and disseminated among all States in the country for implementation. This guidebook serves as a tool for such codification and can be used as a reference for States while adopting suitable road safety measures. Further, mechanisms to guide stakeholders in implementation of a certain measure should be in place. With the scaling up and replication of the good practices, there can be a notable difference in the situation of road safety in the country.

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