Grant Thornton

AMCHAM INDIA

Driving change: Enhancing road safety through technology and partnerships

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Every year, India witnesses 4,80,000 road accidents and 1,80,000 deaths, amongst the highest in the world. Out of these deaths, 66.4% are in the age group of 18-45.

Cutting-edge technologies are an important defining factor, to support the vision of the Government of India of reducing accidents and mortality on roads and highways significantly.

During the "Golden Hour", which is the most crucial time period for timely action, technological interventions like AI-powered systems can analyse real-time data from cameras, sensors, and vehicle communication systems to detect accidents quickly, help connect with the police, hospitals and ambulances to ensure that the most critical resources are deployed to the scene of the accident as quickly as possible to save lives and reduce accident injuries.

This AMCHAM – Grant Thornton report 'Driving Change : Enhancing Road Safety Through Technology Partnerships' highlights key global and Indian infrastructure challenges for road safety, suggests actionable recommendations for enhancing road safety with technological interventions encompassing - safe road designs, road engineering standards, signages, construction materials, preventive maintenance and asset management, vehicle engineering, golden hour response, education and awareness for road safety, trauma care assistance, driver behavior and strengthening governance, accountability, and policy enforcement. Case Studies of US companies demonstrating technology being leveraged to enhance road safety are included.

The report is an attempt to enhance road safety in India and save lives, with technology interventions.

Foreword

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Currently, road safety is a pressing global issue, with approximately 1.19 million fatalities in 2023, making road crashes one of the leading causes of death worldwide. In India, the situation is particularly alarming, highlighting an urgent need for comprehensive road safety measures. Addressing this challenge requires a multi-pronged approach that integrates policy reforms, infrastructure enhancements, emergency response improvements, and adoption of advanced technologies.

Technology plays a transformative role in reducing road accidents and improving mobility safety. Intelligent Transportation Systems (ITS) enable real-time traffic monitoring, predictive analytics help prevent high-risk incidents, and Advanced Driver Assistance Systems (ADAS) enhance vehicle safety through automation. Vehicle-to-Everything (V2X) communication improves coordination between vehicles, road infrastructure, and pedestrians, reducing the likelihood of collisions. Telematics and AI-powered traffic management solutions are also being deployed to optimise mobility and ensure safe driving conditions.

Beyond accident prevention, technology is also strengthening post-crash response. AI-enabled emergency systems, GPS-integrated ambulances, and automated crash detection mechanisms can help reduce response times and improve survival rates. Ensuring nationwide adoption of these solutions requires collaboration between governments, industries, and research institutions. Seamless integration of emergency care with insurance frameworks and legal protections, such as Good Samaritan laws, is also crucial to ensuring timely intervention.

India and the US have significant opportunities for collaboration in road safety. The US has successfully implemented AI-driven traffic management systems, insurance-backed emergency care models, and regulatory frameworks supporting autonomous vehicle technology. These best practices can provide valuable insights for India, where scaling AI-based road safety solutions and updating regulatory frameworks to accommodate new vehicle technologies are priorities.

Bilateral partnerships can also drive innovation in two-wheeler safety, which accounts for a substantial share of road fatalities in India. Co-developing pilot programmes for helmet compliance, rider monitoring systems, and high-visibility vehicle markings can help improve safety outcomes for vulnerable road users. Additionally, fostering innovation through startup grants, hackathons, and regulatory sandboxes can accelerate the development of road safety technologies tailored to India's unique challenges.

Ultimately, improving road safety is a shared responsibility of governments, private sector, and civil society. By leveraging advanced technology, strengthening regulatory frameworks, and fostering global collaboration, India can work towards significantly reducing road traffic fatalities while building a more efficient and safer transportation ecosystem.

01

Introduction

1.1 Overview of global road safety challenges

According to the World Health Organization (WHO), road crash is one of the leading causes of death, and approximately 1.19 million people die each year because of road traffic crashes — this corresponds to a rate of 15 road traffic deaths per 100,000 population as of 2021. This is only a marginal drop of 5% as compared to the 1.25 million deaths in 2010. Road traffic deaths and injuries remain a major global challenge, being the leading cause of death among youth and children aged 5–29 years and the 12th leading cause of death across all age groups.

Breakup of fatalities by vehicle type (global):

Vehicle Type	Global statistics	Region of the Americas	Eastern Mediterranean Region	European Region	African Region	South-East Asian Region	Western Pacific Region
Powered two/three wheelers	30%	25%	17%	12%	14%	46%	29%
Four wheelers	25%	33%	41%	50%	32%	12%	14%
Pedestrians	21%	17%	26%	25%	33%	17%	23%
Cyclists	5%	3%	1%	6%	3%	3%	15%
Occupants of vehicles carrying more than 10 people, heavy goods vehicles, and "Other" users	19%	22%	15%	7%	18%	22%	19%

As per WHO, approximately 10% of road traffic deaths are related to drunk driving. Overspeeding is another pertinent factor contributing to road fatalities, along with non-use of helmets among motorcyclists and passengers.

Global status report on road safety 2023 survey (114 countries reporting on at least one)	
Exceeding speed limit	1-66%
Drunk driving	10% of fatalities (77 countries)
Non-use of helmet (adult)	20% of drivers (out of 44 countries);
	20% of passengers (out of 39 UN Member states)
Non-use of seat belts	20% drivers (57 countries);
	30% front seat passengers (50 countries);
	50% rear seat passengers (42 countries)

1. WHO

Critical challenges:

- **Limited legislation laws around multimodal transport:** Around 60% of global population is expected to live in urban settings by 2030, indicating increased demand for multimodal mobility and utilising opportunities created by technological innovations. Despite the potential benefits of multimodal transportation and need to ensure that vulnerable road users are equally protected as other users, only few countries (till date) have systematically assessed multimodal transport planning as a part of their road safety strategies.

- **Safe road infrastructure:** An ideal road infrastructure mechanism must aim to enhance safety and accessibility, including for persons with disabilities, and facilitate transfers from one transport mode to another. A non-representative sample of near 5,00,000 km of paved road evaluated in 82 countries across regions and income levels were conducted using star-based road safety scoring system developed by the International Road Assessment Programme (iRAP), which rates roads from 0-5. With a 3-star rating being widely accepted as minimum acceptable rating, the results are as follows:

Proportion of paved roads with 3-star or higher rating, by user group (5,00,000 kms evaluated, globally)	
Pedestrians	**21%**
Cyclists	**23%**
Powered two/three wheelers	**21%**
Four wheelers	**40%**

- **Safe vehicles:** There are two types of laws essential for ensuring vehicle safety: legislation specifying requirements and standards for core safety equipment in vehicles and legislation on inspection and assessments. Just over half of countries (88) currently have legislation that specifies the requirements and standards for seatbelts and seatbelt anchorages and only around a third of all countries have legislation on other vehicle core safety elements, including front and side impact protection, electronic stability control, pedestrian protection, and braking systems. With respect to consumer-oriented safety tests, only 87 countries report having customer-oriented crash test programmes, such as New Car Assessment programme (NCAP) tests. Still only 25 countries report disseminating safety-rating results.

- **Speed management and impaired driving:** Based on the survey conducted by WHO, 163 participating countries reported having speeding laws, of which 58 meet WHO best practices (including a national limit, an urban speed limit of 50 km/hr or lower, and the ability of local authorities to adapt speed limits to local contexts), implying a significant deviation. The use of speed cameras is mentioned in the speed laws of 81 countries.

  Additionally, drinking alcohol increases the risk and severity of crashes significantly. In high-income countries, approximately 20% of fatally injured drivers have Blood Alcohol Concentration (BAC) levels above the legal limit. For low-and-middle-income countries, between 33% and 69% of fatally injured drivers are reported to have BAC levels above the legal limit.

- **Post-crash response:** Post-crash care and survival is highly time-sensitive and requires intervention from multiple authorities — including health, justice and finance. Having a nationwide emergency number, immediate first-aid and healthcare, seamless insurance policy care, adequate justice and legal system are important in ensuring financial and psychological protection of victims. There is also a need for immediate care to be provided by lay bystanders whose interventions can be lifesaving. Encouraging people to do so requires protection from civil liability (Good Samaritan laws).

1.2 Economic impact of road crashes challenges

On average, road accidents cost around 3% of a country's Gross Domestic Product (GDP), with over 90% of the fatalities occurring in low- and middle-income countries. Relative to the size of the countries' motor vehicle fleets and road networks, there is a disproportionately high number of fatalities in low- and middle-income countries compared to high-income countries.

Additionally, the risk of death is three times higher in low-income countries than in high-income countries despite these countries having less than 1% of all motor vehicles.

	High income	Upper middle-income	Lower middle-income	Low-income
Population	16%	32%	43%	9%
Powered vehicles	28%	38%	34%	<1%
Paved roads*	88%	2%	10%	<1%
Estimated road fatalities	**8%**	**35%**	**44%**	**13%**

*excludes expressways

The source of this information is the World Bank estimated 2022 Gross Domestic Product and the following are the cut-off points (in USD Mn.): less or equal than USD 1,085 low-income; USD 1,086 to USD 4,355 lower-middle-income; USD 4,256 to USD 13,205 upper middle- income; USD 13,205 or more, high-income.

It is estimated that between 2015 and 2030, road injuries are expected to cost the world economy by USD 1.8 trillion through healthcare expenditures (that would otherwise have been used for savings or investment) and losses in employment due to mortality and morbidity. [2]

1.3 Decade of action for road safety (2021-2030)

Among the 17 sustainable development goals (SDGs) of the 2030 agenda for sustainable development, the two targets, which specifically target road safety, include:

- SDG Target 3.6: Halving the number of global deaths and injuries from road traffic crashes
- SDG Target 11.2: Providing access to safe, affordable, accessible and sustainable transport systems as well as improve road safety for all

2. "https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(19)30170-6/fulltext"Global macro economic burden of road injuries

The WHO and the United Nations (UN) have collaborated with the UN Road Safety partners to "Improve global road safety." The target of the programme is to prevent 50% of road traffic deaths and injuries by 2030. Over the next decade, there are expected to be 13 million deaths and 500 million injuries on the road, particularly in low and middle-income countries.

The global plan describes what is needed to achieve this target and calls on governments and partners to implement and integrate the Safe Systems Approach, as highlighted below:

Global plan (Decade of action for road safety 2021-2030)

What to do

- Multimodal transport and land use planning
- Safe road infrastructure
- Safe road use
- Safe vehicles
- Post-crash response

How to do it

- Legal frameworks
- Speed management
- Capacity development
- Ensuring a gender perspective
- Technological intervention
- Financing
- Focus on low and-middle-income countries

Who to do it

- Government focus
- Civil society- Academia, NGOs, Youth
- Funders- Public and Private
- Private sector
- UN agencies

The WHO's strategies to control road accidents include strengthening laws, increasing enforcement, redesigning streets, and using data to enhance road and traffic safety. The UN provides a strong legal framework for countries to build domestic legal foundations to contribute to road safety.

Recommended actions under the plan include:

- **Multimodal transport and land use planning:** With 70% of the population expected to live in urban settings by 2030, there must be an optimal mix of multimodal transport to ensure safety as well as equitable access.
- **Safe road infrastructure:** This must be planned, designed, built, and maintained to enable multimodal mobility.
- **Safe vehicles:** Vehicle safety should be paramount and should be at the centre of vehicle design.
- **Safe road use:** Road traffic laws must be implemented effectively.
- **Effective post-crash response:** Appropriate, integrated, and coordinated care must be provided.

Requirements for implementation

- **Financing:** Long-term, sustainable investment for developing safe road infrastructure
- **Legal frameworks:** UN road safety legal instruments provide a strong foundation, which can be embedded in domestic legal frameworks
- **Speed management:** Appropriate speed management impacts both crash likelihood and severity, as well as improves the effectiveness of other safety interventions
- **Capability development:** Continuous knowledge development and sharing
- **Technology:** Vehicle-to-vehicle and vehicle-to-infrastructure intelligence data can contribute to safer and more sustainable mobility
- **Focus on low- and middle-income countries:** With more than 90% of fatalities occurring in low-income countries, proactive emphasis and support from high-income countries can help in combating the critical issue more effectively

02

Current landscape of road safety in India

Scripting the country's growth story, India has the second largest road network globally, with around 66.71 lakh km, as of December 2023.[3] The breakup of various categories is as under:

	Length (in Lakh Km.)	Percentage of total road network
National highways	1.46	2%
State highways	1.80	3%
Other roads	63.45	95%

National Highways play a pertinent role in the country's economic and social development, by enabling efficient movement of freight and passengers and improving access to markets. The National Highway (NH) network increased by ~60% from 91,287 km in 2014 to 1,46,145 km in 2023.

Overall, the road network moves around 64% of all goods, making it vital to the country's GDP. With more than 90% of India's total passenger vehicle traffic using roads to commute, road safety must be regarded with highest importance.

2.1 Statistics: India's road crash fatalities and injuries

India records the highest number of road accident fatalities globally with a reported road death rate of 250 per 10,000 km, higher than the rates in the US (57), China (119) and Australia (11). In 2023, India recorded over 4.80 lakh road accidents which resulted in over 1.72 lakh deaths.

Total road accidents recorded in 2023 (in India) [4]	**4,80,000**
Deaths caused by accidents	1,72,000
Casualties caused	3,08,000

- **Total accidents and fatalities:**
  - In 2023, around **54,000 fatalities** occurred due to two-wheeler riders **not wearing helmets**; 16,000 deaths were linked to **non-use of seat belts**, and 12,000 fatalities were attributed to **vehicle overloading.**
  - Additionally, around 34,000 accidents involved **drivers without valid licenses.**
- **Accident rate:**
  - The number of **crashes increased by 4.2%** in 2023 as compared to 2022.
  - On average, India experienced 1,317 road crashes and 474 fatalities each day, translating to **55 crashes and 20 fatalities every hour.**
  - The **road crash severity**, measured as fatalities per 100 crashes, **marginally declined from 36.5 in 2022 to 36 in 2023.**
- **Demographic insights:**
  - In 2023, India saw **10,000 minors and 35,000 pedestrians** killed in road accidents.
  - **Pedestrians** and **two-wheeler users** account for a significant proportion of deaths — **44.8%** and **20%**, respectively.
- **Regional disparities:**
  - **Uttar Pradesh** has the **highest number of road accident deaths in India.** In 2023, the state saw 44,000 accidents resulting in 23,650 fatalities, including 1,800 minors, 10,000 pedestrians, and two-wheeler users.
  - As per another statistic, in 2022, Tamil Nadu reported the highest number of road accidents with 64,105 (13.9%) accidents, followed by Madhya Pradesh with 54,432 (11.8%) accidents.

More than 4.90 lakh lives have been lost between 2021-2023 in deaths due to negligence related to road accidents.

3. PIB
4. MoRTH and PIB

Major parameters of road accidents- 2022 vis-à-vis 2021

Parameter	2021	2022	%age change (rounded to nearest absolute no.)
Number of accidents	4,12,432	4,61,312	12%
Number of persons killed	1,53,972	1,68,491	9%
Number of injuries	3,84,448	4,43,366	15%
Accident severity (persons killed per 100 accidents)	37.3	36.5	2%

Total number of accidents- by categories of roads during 2022 vis-à-vis 2021

Parameter	2021	2022	%age change
National Highways	1,28,825	1,51,997	18%
%age of total	31.2%	32.9%	5%
State Highways	96,382	1,06,682	11%
%age of total	23.4%	23.1%	(1%)
Other roads	1,87,225	2,02,633	8%
%age of total	45.4%	43.9%	(3%)
All roads	4,12,432	4,61,312	12%

- National Highways make up for the highest percentage increase (for total number of accidents), accounting for a higher number of accidents than on state highways in absolute terms.
- Out of the total 1,51,997 accidents on National highways in 2022 — 61,038 were killed and 1,44,352 were injured. The highest number of deaths were accounted for by two-wheelers (over 25,000), followed by four wheelers and pedestrians (over 10,000 for each).
- Out of the total 1,06,682 accidents on State Highways in 2022 — 41,012 were killed and 1,06,485 were injured.
- Out of the total 2,02,633 accidents on Other roads in 2022 — 66,441 were killed and 1,92,529 were injured.

Reported road accident fatalities by vehicle type (2022)

Vehicle type	Percentage deaths in road accidents (Total: 1,68,491)
Two-wheelers	44.5%
Pedestrians	19.5%
Cars, taxis, vans and LMVs	12.5%
Trucks/lorries	6.3%
Auto-rickshaws	3.9%
Buses	2.4%
Bicycles	2.9%
Other non-motor vehicles (including e-rickshaw)	1.4%
Others	6.7%

- As two-wheelers are one of the most popular means of transportation in India, they account for the highest number of road accidents by vehicle type.
- The reasons for two-wheeler accidents include poor roads, unsafe (or no) helmets, and a lack of education. The use of correct and safe helmets could reduce the risk of fatal injuries by 42% and head injuries by 69%, according to a report by the WHO.
- A majority of two-wheeler accidents occur in rural areas, which account for around 70% of the fatalities.

Rural and urban breakup (2022)

Rural areas	**38%**
Total cases	1,77,269
Urban areas	**62%**
Total cases	2,84,043

- There is a lack of awareness regarding road safety and measures to ensure road safety among the rural population of the country.
- Along with an increased awareness, improved road and transportation system is imperative to reduce the total accident cases in the rural areas.

Breakup of road accident fatalities in 2022

Over-speeding	1,19,904
Drunken driving/Consumption of alcohol & drug	4,201
Driving on the wrong side	9,094
Jumping red light	1,462
Use of mobile phones	3,395
Others	30,435
Total	**1,68,491**

2.2 Enhancing road safety: Addressing key infrastructure challenges

India is committed to improving road safety by strengthening adherence to traffic rules and enhancing enforcement measures. To improve road safety in India, it is imperative to recognise the roadblocks we largely face, so that essential solutions can be implemented to overcome them.

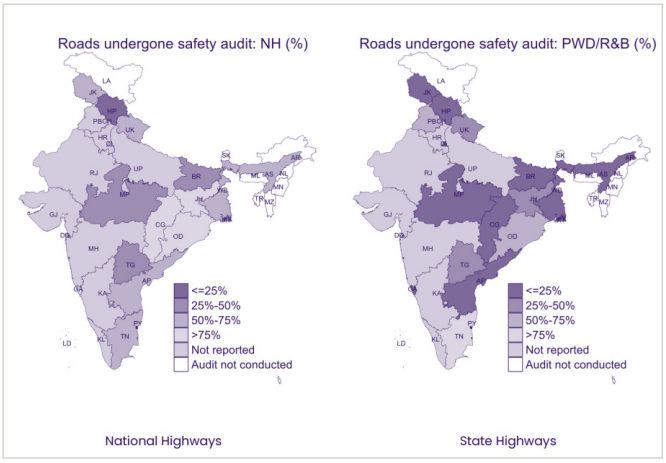
2.3 Infrastructure and road design improvements

A well-planned and well-maintained road network plays a crucial role in reducing accidents. Key areas of focus include:

- **Optimising road design:** Thoughtfully planned roads with well-designed curves, adequate lane width, and efficient drainage systems can significantly reduce accident risks. Strengthening project planning and execution will further enhance road safety.
- **Enhancing signage and markings:** Well-designed road signages and lane markings are fundamental to traffic management and road safety. They provide critical guidance to drivers, reduce confusion, and improve reaction times, particularly in high-traffic zones, accident-prone areas, and highways. Companies specialising in road safety and infrastructure can significantly enhance signage and markings by integrating advanced materials, digital technologies, and smart systems.

  One key innovation is **retroreflective and thermoplastic road markings**, which improve night-time visibility and withstand harsh weather conditions. High-durability, skid-resistant materials can also be deployed to ensure longevity and safety in extreme environments. Companies producing smart road signs can integrate **LED-based adaptive signage** that adjusts brightness and content based on traffic conditions, weather or incidents ahead.

  Additionally, the use of **connected infrastructure** — such as RFID-enabled road markers and AI-powered sign recognition systems — can support autonomous and connected vehicles, ensuring seamless navigation. Collaboration with city planners and government agencies in deploying **geospatial mapping and augmented reality overlays** for navigation apps can further enhance driver awareness. By leveraging these advanced technologies, companies can play a pivotal role in improving road safety, reducing traffic-related fatalities, and building smart, safe transportation networks.
- **Proactive road maintenance:** Regular upkeep, including pothole repairs and surface levelling, ensures smoother and safer commuting, particularly benefiting two-wheeler riders.
- **Strengthening safety features:** Installing guardrails, pedestrian crossings, underpasses, foot overbridges, and traffic calming measures enhances protection for all road users, especially in urban areas.
- **Advancing road engineering standards:** The states were assessed on initiatives taken to rectify black spots on National and State Highways, and other roads (the audit reported the presence of traffic calming measures at appropriate locations). Four cities in each state were audited for the presence of safe pedestrian paths, appropriate signages and markings as per IRC standards. Only eight states had audited more than half the length of their National Highways, while only three had audited more than half the length of State Highways. Other states had either not reported or conducted a road safety audit. [5]



Disclaimer: Maps are for graphical purposes only. They do not represent a legal survey

5. https://tripc.iitd.ac.in/assets/publication/India_Status_Report_on_Road_Safety-20242.pdf

2.4 Driver behaviour and training gaps

A lack of adherence to rules and awareness of these regulations contributes significantly to countrywide accidents. A few challenges can be identified that hamper road safety in India:

- **Promoting safe driving practices:** Human error, such as over-speeding and non-compliance with safety measures like helmets and seat belts, remains a major concern. In 2023, over-speeding contributed to 68.1% of road fatalities. Strengthening awareness and enforcement can encourage safer driving habits.
- **Expanding road safety awareness:** Despite interventions, India still faces significant gaps in enforcing road safety regulations. Continued efforts in public education on the benefits of safety features such as airbags, anti-lock braking systems (ABS), and seat belts can help instil a stronger road safety culture.
- **Enhancing access to driver training:** Expanding training infrastructure, especially in rural areas, will ensure aspiring drivers receive comprehensive education on traffic laws and safe driving techniques.
- **Developing advanced training programmes:** Specialised training, particularly for commercial vehicle operators, can better equip drivers to handle complex road situations, improving overall road safety.
- **Strengthening crash data monitoring:** Establishing a robust national database for crash-level data can enhance policy planning and targeted interventions to reduce accident risks.
- **Advancing vehicle safety standards:** Improvements in vehicle engineering and safety technology have already started making a positive impact. Programmes such as Bharat NCAP are helping set higher safety benchmarks for vehicles, aligning with global best practices.

2.5 Lack of Golden Hour response

Timely emergency response plays a crucial role in saving lives and reducing the impact of road accidents. Strengthening infrastructure, public awareness, and coordination among key stakeholders can significantly improve outcomes for accident victims.

- **Improving emergency response systems:** Expanding Emergency Medical Services (EMS) coverage, investing in infrastructure, and training more personnel can help ensure accident victims receive timely medical attention. The key focus areas are strengthening ambulance networks and integrating technology for faster response times.
- **Encouraging bystander assistance:** Raising awareness about legal protections for bystanders and promoting public confidence in assisting accident victims can help reduce delays in providing first aid and transportation to hospitals.
- **Expanding trauma care facilities:** Increasing the number of well-equipped trauma centres, particularly in rural areas, will enhance access to immediate and effective medical care during the critical "golden hour."
- **Strengthening coordination among agencies:** Enhancing collaboration between police, EMS, and hospitals can improve the efficiency of ambulance dispatch, on-site medical care, and victim transportation. Implementing centralised communication systems can further streamline emergency response efforts.
- **Promoting first aid awareness:** Educating the public about basic first aid measures and the importance of the golden hour can empower individuals to take immediate action in emergencies, improving survival rates.
- **Increasing ambulance services:** Expanding the availability of ambulances and ensuring they are well-equipped with essential trauma care facilities can significantly improve pre-hospital care and emergency response efficiency.
- **Effective policy implementation:** Policies such as the Motor Vehicles Amendment Act 2019, which includes provisions for cashless treatment during the golden hour, are crucial steps towards improving emergency care. A continued focus on implementation and accessibility will ensure that these policies have a lasting impact.

2.6 Government and policy interventions to enhance road safety

Mitigation measures: Education, Engineering, Enforcement and Emergency

The Ministry of Road Transport and Highways (MoRTH) has formulated a multi-pronged strategy to address the critical issue of road safety based on the 4E approach:

- **Education:**

  The MoRTH has undertaken several initiatives to enhance road safety through public awareness, driver training, and professional education. These efforts instils responsible driving behaviour, improve road infrastructure management, and create a culture of safety across the country.

  1. **Public awareness and advocacy**

     To ensure widespread awareness about road safety, MoRTH implements various publicity campaigns through social media, electronic, and print media. Additionally, the Ministry provides financial assistance to different agencies to conduct Road Safety Advocacy programmes promoting responsible road use among citizens. The observance of National Road Safety Month for one week each year further strengthens these efforts, fostering public engagement and commitment to safer roads.

  2. **Driving training and skill development**

     Recognising the importance of proper training, MoRTH has launched initiatives to establish Institutes of Driving Training & Research (IDTRs), Regional Driving Training Centres (RDTCs), and Driving Training Centres (DTCs) at the state and district levels. These institutions provide structured training programmes to enhance driving skills, ensuring that both new and existing drivers receive proper education on traffic rules, safe driving practices, and vehicle handling.

  3. **Professional road safety education**

     MoRTH has mandated a Certification Course for Road Safety Auditors to strengthen technical expertise in road safety. This course is compulsory for technical officers of all road-owning agencies under the Ministry, up to the level of Superintending Engineer or equivalent. This initiative equips officials with specialised knowledge in road safety audits, and helps enhance the design, maintenance, and overall safety of India's road network.

     Through these comprehensive education and awareness measures, MoRTH is fostering a proactive approach to road safety, ensuring better compliance with traffic regulations, improved driver behaviour, and safe roads for all.

- **Engineering:**

1. **Road engineering:** MoRTH has integrated road safety into the design, construction, and maintenance of highways to minimise accidents and enhance overall road safety.

   Key initiatives include:

   i. **Mandatory road safety audits (RSA):** All highway projects undergo RSAs at multiple stages — design, construction, operation, and maintenance — conducted by third-party experts.

   ii. **Black spot identification and rectification:** High-priority efforts are underway to identify and address accident-prone areas on National Highways, improving road safety in critical locations.

   iii. **Dedicated road safety officers (RSOs):** Each Regional Office now has an RSO responsible for overseeing safety audits, black spot rectification, and other road safety measures.

   iv. **Model Safe Roads and Construction Zones:** Selected highway stretches and ongoing projects are being developed as Model Safe Roads and Model Safe Construction Zones to implement and showcase best safety practices.

   v. **e-DAR Project for Accident Data Management:** The Electronic Detailed Accident Report (e-DAR) project is creating a central repository for real-time accident reporting and analysis, aiding in data-driven policy decisions.

   vi. **Implementation of safety guidelines:** MoRTH, in collaboration with the Indian Roads Congress (IRC), continues to issue updated safety codes and guidelines to ensure consistent implementation of best practices on National Highways.

2. **Vehicle engineering:** The Ministry has introduced several regulations and safety mandates to improve vehicle engineering, ensuring enhanced protection for passengers, pedestrians, and other road users.

   Mandatory safety features:

   i. **Airbags:** Front passenger airbags are now mandatory to reduce the risk of severe injuries in case of a collision.

   ii. **Child safety regulations:** New norms require safety harnesses, crash helmets, and speed restrictions (40 kmph) for children under four years riding on motorcycles.

   iii. **Seat belt reminders and speed warning systems:** All M1 category vehicles (passenger cars) must have seat belt reminders for both the driver and co-driver, a manual override for central locking, and an over-speed warning system.

   Advanced braking and collision protection:

   i. **Anti-Lock Braking System (ABS):** This is mandated for certain L (less than four-wheelers), M (passenger vehicles), and N (goods carriers) category vehicles to prevent skidding and enhance control during braking.

   ii. **Crash safety norms:** Vehicles must meet stringent crash test approvals, including protection in offset frontal, lateral, and head-on collisions, along with pedestrian protection requirements to minimise accident impact.

   Speed and Fire Safety Regulations:

   i. **Speed limiting devices:** Required for all transport vehicles, with exemptions for emergency and enforcement vehicles.

   ii. **Fire safety in buses:** Fully built buses (22+ passengers) must comply with fire detection, alarm, and suppression systems, with additional fire safety mandates for school and category M3 buses.

   Automated vehicle testing and scrappage policy:

   i. **Inspection and certification centres:** Established in each state/UT for automated vehicle fitness testing.

   ii. **Automated testing stations (ATS):** Implemented for standardised fitness certification of vehicles through automated equipment.

   iii. **Vehicle scrapping policy:** Designed to phase out old, unfit, and polluting vehicles through structured incentives and disincentives, promoting safer and environmentally friendly transportation.

   By integrating advanced vehicle safety technologies and rigorous testing mechanisms, these measures contribute to a safer and more efficient road transport ecosystem in India.

- **Enforcement:**

The enforcement of road safety laws plays a crucial role in ensuring compliance with traffic regulations and reducing road accidents. MoRTH has implemented stringent measures to enhance enforcement through legal frameworks and technology-driven solutions.

1. **Motor Vehicles Act, 1988 & Amendment (2019):** The Motor Vehicles (Amendment) Act, 2019 introduced significant changes to India's road safety regulations, aiming to reduce accidents, enhance accountability, and streamline vehicle-related processes. This amendment brought in stricter penalties, improved infrastructure for accident victims, and strengthened vehicle fitness and driver training standards.

   Key features of the Act

   i. **Cashless treatment during the 'golden hour':** The Act mandates cashless treatment for road accident victims during the 'golden hour'—the crucial one-hour period following an accident, where timely medical intervention can significantly increase survival chances.

   ii. **Enhanced compensation for accident victims:** The compensation for hit-and-run cases has been increased significantly — from INR 25,000 to INR 2,00,000 in case of death and from INR 12,500 to INR 50,000 for grievous injuries.

iii. **Ensuring road and environmental safety:** The Act holds vehicle manufacturers accountable for defects compromising road safety or contributing to environmental damage. If a vehicle is found unfit for use, manufacturers must either reimburse or replace the vehicle.

iv. **Establishment of a National Road Safety Board:** A National Road Safety Board has been introduced to advise the central and state governments on traffic management and road safety measures.

v. **Motor Vehicles Accident Fund for compulsory insurance:** A Motor Vehicles Accident Fund has been set up to provide compulsory insurance for all drivers, ensuring financial protection for accident victims.

vi. **Automated fitness testing for vehicles:** The Act mandates automated vehicle fitness tests to identify and remove unfit vehicles from the roads to enhance road safety. It also strengthens environmental and safety regulations, enforcing penalties for violations.

vii. **Regulation of taxi aggregators:** The Act formally recognises taxi aggregators (such as ride-hailing platforms) as digital intermediaries connecting passengers with drivers. These companies must obtain state government licenses and comply with the Information Technology Act, 2000.

viii. **Online driving license issuance:** The Act streamlines the licensing process by allowing online issuance of learner's licenses and mandating digital identity verification to curb fake licenses. Additionally, the validity of commercial driving licenses has been extended from three to five years.

ix. **Creation of a National Register for vehicles and driving licenses:** A National Register for Driving Licenses and Vehicles has been introduced to ensure uniformity in vehicle registration and licensing. The Government's 'Sarathi' and 'Vahan' portals will be integrated for seamless tracking and verification.

x. **Protection of Good Samaritans:** The Motor Vehicles Act legally protects Good Samaritans — bystanders who assist accident victims — from legal and procedural harassment. Even if their actions inadvertently lead to the victim's death, they cannot be held liable.

xi. **National Transportation Policy:** The Act promotes the formulation of a National Transportation Policy, developed collaboratively by the central and state governments. This policy aims to improve road transport infrastructure and enhance safety measures.

2. **Electronic monitoring and smart enforcement:** To ensure real-time enforcement and transparency, MoRTH issued G.S.R. 575(E) notification (August 2021), specifying the use of electronic enforcement devices, including:

   i. Speed cameras and speed guns for monitoring over-speeding

   ii. Closed-Circuit Television (CCTV) cameras for surveillance at key locations

   iii. Automatic Number Plate Recognition (ANPR) systems to track violations

   iv. Body-worn and dashboard cameras for law enforcement officials to ensure fair and accountable traffic policing

   v. Weigh-in-motion (WIM) machines to monitor overloaded vehicles and prevent road damage

   By integrating legal reforms with smart enforcement technologies, these initiatives aim to create a safer and more disciplined road environment, ensuring stricter adherence to traffic laws and reducing accident risks.

- **Emergency:**

A robust emergency response system is essential for minimising fatalities and ensuring timely medical care for road accident victims. MoRTH has implemented key measures to strengthen emergency care and support for accident victims:

i. **Protection for Good Samaritans:** To encourage bystander assistance in road accidents, the Ministry introduced **Good Samaritan rules (GSR 594(E), 29th September 2020)**. These rules protect individuals who voluntarily provide emergency care or transport accident victims to hospitals. Good Samaritans are safeguarded from legal or procedural hassles, ensuring they can assist without fear of harassment or liability.

ii. **Enhanced compensation for hit-and-run victims:** Recognising the need for financial support for accident victims, MoRTH issued a notification on 25 February 2022 to increase compensation for hit-and-run cases:

   Grievous injuries: Compensation raised from INR 12,500 to INR 50,000.

   Fatalities: Compensation increased from INR 25,000 to INR 2,00,000.

   This initiative provides critical financial aid to victims and their families, helping them manage medical expenses and recovery costs.

iii. **Strengthening ambulance services on Highways:** To ensure timely medical attention, the National Highways Authority of India (NHAI) has deployed ambulances with paramedical staff, emergency medical technicians (EMTs), and nurses at toll plazas along completed highway corridors. This measure aims to enhance golden hour response by providing immediate on-site medical care and swift transportation to hospitals.

A comprehensive approach to road safety requires a strong focus on **Education, Engineering, Enforcement, and Emergency Care.** India can significantly reduce road accidents and fatalities by enhancing driver awareness, improving road and vehicle design, ensuring strict law enforcement, and strengthening emergency response systems. Continued collaboration between government, industry, and the public will be key to building a safer and more resilient road network.

03

Technological interventions for road safety

3.1 Enhancing road safety

Intelligent Transportation Systems (ITS) comprises a wide range of technologies that collaborate to enhance road safety and provide crucial information. Road traffic safety systems integrate various ITS technologies to minimise the risk of accidents, injuries, and fatalities. They utilise advanced communication, sensing, and radar technologies to transmit information, involving numerous components and mechanisms. These technologies improve real-time traffic management, shorten travel times, enhance incident response, and more.

3.2 Advanced Driver Assistance Systems

Advanced Driver Assistance Systems (ADAS) are sophisticated technologies designed to enhance driver safety. They utilise sensors and cameras to monitor the road, alerting drivers to potential hazards and even taking control to prevent accidents. ADAS enhances driver awareness by providing constant feedback and warnings, helping drivers notice potential dangers. It reduces fatigue through features like adaptive cruise control, making long drives less tiring. Additionally, ADAS decreases accident rates, leading to fewer injuries, less vehicle damage, and reduced repair costs. Key features include:

- **Adaptive cruise control:** This feature maintains a safe distance from the vehicle ahead by automatically adjusting speed to match traffic conditions.
- **Lane departure warnings:** This system alerts drivers if they begin to drift out of their lane without using a signal.
- **Collision avoidance systems:** These systems identify potential collisions and can either warn the driver or apply brakes to prevent a crash.

Examples of ADAS Technologies:

- **FedEx:** The trucks are equipped with lane departure warnings and collision avoidance systems, which have contributed to a 30% reduction in accidents.
- **UPS:** The company utilises adaptive cruise control in delivery vans, helping drivers maintain a safe distance from other vehicles and reducing rear-end collisions.
- **DHL:** Since incorporating ADAS into their fleet, DHL has experienced a 20% reduction in accidents. Drivers also report feeling safer and more confident on the road.
- **Amazon:** Amazon delivery vans are equipped with collision avoidance systems, which help navigate busy streets and prevent potential crashes, ensuring the safety of both drivers and packages.

3.3 Vehicle-to-Everything

Vehicle-to-Everything (V2X) is a communication system enabling vehicles to interact with each other (V2V), infrastructure (V2I), and pedestrians (V2P). This technology facilitates sharing crucial information, such as sudden stops or traffic light changes, enhancing road safety and efficiency. V2X technology optimises routes for logistics companies, saving time and fuel while ensuring timely deliveries. Real-time traffic updates make deliveries more predictable by helping drivers avoid delays from accidents or heavy traffic. The impact on road safety includes:

- **Enhanced traffic flow and reduced congestion:** V2X technology enhances traffic flow by enabling vehicles to communicate and adjust speeds to avoid traffic jams. Traffic lights can also adapt based on real-time conditions, minimising wait times.
- **Real-time hazard warnings and preventive measures:** With V2X, vehicles receive real-time alerts about hazards, such as accidents ahead. These alerts enable drivers to take preventive actions, like slowing down or changing lanes, improving overall road safety.

Examples of V2X Technologies:

- **FedEx:** FedEx leverages V2X for real-time traffic updates, allowing drivers to select optimal routes, thereby avoiding traffic jams and accidents.
- **UPS:** UPS has integrated V2X technology into some of its delivery trucks, enabling them to communicate with traffic lights. This helps avoid red lights, save fuel, and speed up deliveries.
- **DHL:** DHL has seen a 15% reduction in delivery times after adopting V2X technology, as their trucks can bypass traffic jams and find quicker routes.
- **Amazon:** Amazon's delivery fleet uses V2X to navigate busy cities, helping drivers find the best routes and making deliveries faster and safer.

3.4 Telematics and fleet management system

Telematics combines telecommunications and information processing to monitor and manage fleet vehicles, enhancing operations. It improves road safety by providing feedback on driving behaviour, reducing risky habits, and predicting maintenance needs to prevent breakdowns and accidents. This proactive approach ensures vehicles run smoothly and safely. Key features of Telematics are:

- **GPS tracking:** Enables companies to view the precise real-time location of their vehicles.
- **Driver behaviour monitoring:** Tracks driving behaviours such as speed, braking, and acceleration to monitor driver performance.
- **Maintenance alerts:** Notifies managers when a vehicle requires maintenance, helping to prevent breakdowns and maintain vehicle condition.

Examples of telematics:

- **FedEx:** FedEx employs telematics to monitor its fleet, tracking vehicle locations and driver behaviours. This system helps improve delivery times and ensures safe driving practices.
- **UPS:** UPS has a comprehensive telematics system that tracks their trucks and monitors maintenance needs. This has significantly reduced breakdowns and kept the fleet in excellent condition.
- **DHL:** DHL utilises telematics to monitor driver behaviour, resulting in a 20% reduction in accidents since the system's implementation. Drivers receive real-time feedback, promoting safer driving habits.
- **Amazon:** Amazon's delivery fleet employs telematics for GPS tracking and maintenance alerts, which has improved their on-time delivery rate by 15%. They also experience fewer vehicle breakdowns due to predictive maintenance.

3.5 Autonomous and semi-autonomous vehicles

Fully autonomous vehicles drive themselves using advanced sensors, cameras, and AI, while semi-autonomous vehicles require some human assistance for tasks like highway driving or parking. These technologies are transforming the logistics industry by reducing accidents and improving delivery efficiency. Although challenges remain, ongoing developments and regulatory support suggest a promising future for autonomous vehicles in logistics. As regulations evolve, more countries are expected to adopt these vehicles, leading to further innovations. Safety implications include:

- **Reduction in human error-related accidents:** Human errors, such as distracted driving or fatigue, cause most accidents. Autonomous vehicles can mitigate these errors by making quick decisions and remaining alert 24/7, resulting in fewer accidents.
- **Challenges and considerations in adoption:** Adopting autonomous vehicles faces several challenges. The technology must advance to handle all driving scenarios, and there are concerns about cybersecurity and hacking. Additionally, legal and regulatory hurdles must be addressed before widespread use is possible.

Examples of autonomous and semi-autonomous vehicles:

- **Nuro:** Nuro employs small, autonomous delivery vehicles to deliver groceries and packages in select cities. These vehicles have successfully reduced delivery times and costs.
- **Einride:** Einride's autonomous trucks are undergoing tests in Sweden, demonstrating potential for safe and efficient long-distance goods transportation.
- **Walmart:** The company is experimenting with autonomous trucks for transporting goods between warehouses, which has helped reduce delivery times and costs.
- **Domino's Pizza:** Domino's has begun using autonomous vehicles to deliver pizzas in certain areas, and customers appreciate the quick and reliable service.

3.6 Predictive analytics and AI for road safety

Predictive analytics uses data to forecast future events, aiding logistics companies in predicting delivery times, maintenance needs, and potential risks. AI enhances this by quickly analysing large datasets to identify patterns and trends. Applications include forecasting demand for better inventory management, optimising routes by predicting traffic patterns, and assessing risks like weather conditions or road hazards. Key features include:

- **Predicting potential hazards:** Predictive analytics can foresee potential hazards before they occur. For instance, it can identify areas prone to accidents due to high traffic or poor road conditions, enabling drivers to take preventive measures like selecting alternative routes or driving more cautiously.
- **Enhancing decision-making processes:** Predictive analytics aids logistics companies in making well-informed decisions. By understanding risks and forecasting outcomes, companies can plan more effectively, resulting in safer and more efficient operations.

Examples of Predictive Analytics and AI:

- **UPS:** UPS leverages predictive analytics to manage its fleet by analysing data to anticipate maintenance needs. This approach has reduced breakdowns by 20% and ensured smooth fleet operations.
- **DHL:** DHL employs predictive analytics to optimise routes by forecasting traffic and road conditions. This has improved delivery times by 15% and significantly reduced fuel consumption.
- **FedEx:** FedEx uses predictive analytics to assess risks on delivery routes, resulting in a 25% reduction in accidents. Drivers receive alerts about potential hazards, promoting safer driving.
- **Amazon:** Amazon utilises AI and predictive analytics to forecast demand and optimise inventory, ensuring product availability and reducing delays. Their delivery fleet also benefits from predictive maintenance, decreasing vehicle breakdowns by 30% and enabling seamless real-time fleet tracking.

3.7 Leveraging technology to enhance road safety- Case Studies (The US and AMCHAM members)

The US Department of Transportation

Industry sector: Government

Road safety initiative: Saving lives with connectivity: a plan to accelerate V2X deployment

Initiative overview:

In its commitment to reducing deaths and serious injuries on the nation's roadways, the US Department of Transportation (USDOT) announced the 'Saving Lives with Connectivity: A Plan to Accelerate V2X Deployment'. The plan will guide the nationwide implementation of vehicle-to-everything technologies and support USDOT's comprehensive approach to achieving zero roadway fatalities.

- The Department acknowledges the significant safety benefits of V2X technology, and this plan will help it advance towards its nationwide adoption.
- The plan was developed through collaboration between public and private partnerships. It offers stakeholders essential information to support the countrywide safe, efficient, and sustainable deployment of interoperable V2X technologies. It aims to accelerate investment, research, and deployment, ensuring market certainty for V2X.
- The US Department of Transportation's Federal Highway Administration (FHWA) plans to award USD 60 million in grants to advance V2X technologies in Arizona, Texas, and Utah. The grants will serve as national models to accelerate the deployment of connected and interoperable vehicle technologies.

Key benefits:

- The initiative aims to enhance road safety, mobility, and efficiency by leveraging technology that allows vehicles and wireless devices to communicate with each other and with roadside infrastructure. This will enable cars to effectively interact with traffic devices and the roadside, providing timely warnings and improving overall traffic management.
- The grants announced aim to support the deployment of V2X technologies, to realise the full life-saving potential of V2X communication. Additionally, they will ensure that connected technologies communicate securely and without harmful interference across various devices and platforms.

Honda US

Industry sector: Auto and auto-components

Road safety initiative: Safety for everyone

Initiative overview:

Honda is enhancing its "Safety for Everyone" initiative by broadening its focus beyond advanced safety and driver-assistive technologies. The company aims to achieve zero traffic collision fatalities involving its automobiles and motorcycles by 2050, including older models still in use.

- **Honda safety driven:** It is a multi-year initiative in collaboration with Discovery Education aimed at reducing the nearly one-third of annual traffic fatalities in the US involving drivers under 25.
- **Rider and driver skills education:** Honda operates three rider education centres in California, Georgia, and Ohio, training over 11,000 riders annually. In 2022, Honda launched the "Safety Training Awareness & Responsibility for Teens" (START) programme in Indiana, with plans to expand to more locations.
- **Community giving supports organisations working to improve traffic safety:** Honda and the Honda USA Foundation have backed numerous programme aimed at helping people safely and confidently enjoy mobility, both on and off the road. Since 2021, they have provided over USD 6 million in funding to nonprofit safety organisations.
- **Driver coaching App:** Introduction of Honda Driver Coaching smartphone app in June 2023 to help improve skills of new drivers and promote safe driving practices. The app provides real-time driving analysis and engaging lessons through a game component. Compatible with many Honda and Acura models equipped with Apple CarPlay, it helps new drivers improve their driving style by analysing inputs like steering, braking, and acceleration, and offers a driving score and tips for improvement.

Key benefits:

- The company is working to increase driver awareness, change driver behaviour, and improve the overall traffic safety ecosystem through collaboration with government, industry, and community partners.
- Entertain and educate students about the physics of a car crash and how different factors can affect the level of risk to passengers.
- The "Pedestrian Safety" teaches students road safety through engaging content, including road rules, signs, and signals. It features an educator guide, family action plans, and e-bike/e-scooter safety activities along-with fun videos.

Magna

Industry sector: Auto and auto-components

Road safety initiative: Impaired driving prevention technology

Initiative overview:

- Magna in 2024, introduced a pre-development technology that uses breath and camera-based systems to combat impaired driving. The technology determines if drivers are 'fit to drive' quickly, reliably, and affordably.
- Combines interior sensing system with camera technology to detect distraction, drowsiness, and intoxication through pupillary signals.
- Utilises infrared sensor technology developed by Senseair for air and gas sensing.
- Cockpit-embedded sensors measure alcohol and carbon dioxide levels in exhalations.
- Passively detects intoxicated drivers with a blood alcohol concentration at or above the legal limit (0.08% in most states, 0.05% in Utah).

Key benefits:

- The new solution focuses on alcohol detection, the most common substance associated with impaired driving crashes.
- Checks driver's fitness in a fast, reliable and affordable way.

Honeywell

Industry sector: Automation, Energy Transition, Aviation

Road safety initiative: Honeywell Titan

Initiative overview:

Honeywell Titan, a next-generation asphalt additive, improves rutting resistance, reduces moisture damage, minimises maintenance, and extends road life. Successful trials with BRO and private highway concessionaires have demonstrated its effectiveness in building safer and more resilient roads. Honeywell also collaborates with CRRI, IITs, NITs, MoRTH, and NHAI to promote best practices in road construction.

Key benefits:

- Enhanced road durability with better resistance to wear and tear
- Reduced maintenance costs through improved material performance
- Increased road safety by minimising surface degradation
- Stronger industry collaboration to drive awareness and innovation in road construction

Trimble

Industry sector: Tech solutions for construction, transportation, and allied industries

Road safety initiative: Advancing road safety through precision construction technology

Initiative overview:

Trimble's Precision AMG Construction leverages data-driven, connected construction and automated machine-guided (AMG) technology to enhance road design, execution, and maintenance. Trimble helps deliver high-quality roads that improve safety and longevity by ensuring tight tolerances and precision in construction. The company actively collaborates with government and industry stakeholders to drive best practices, education, and capacity building in road construction.

Key benefits:

- Improved road quality through precision-driven construction
- Enhanced safety and durability by ensuring accurate design execution
- Optimised operations and maintenance with data-driven asset management
- Promoted stronger industry engagement through education and capacity building

3M

Industry sector: Manufacturing

Road safety initiative: 3M is driving road safety improvements through innovative road signs, pavement markings, and vehicle safety solutions. By leveraging data-driven studies and cutting-edge technology, 3M enhances visibility, traffic management, and infrastructure durability, reducing accidents and improving road discipline.

Initiative overview:

3M has conducted more than 10 studies in collaboration with leading institutes such as CRRI, SPA, SVNIT, and WRI, validating the impact of high-quality road signs, pavement markings, and vehicle conspicuity solutions. Their research highlights:

- **Road signs and road furniture:** A 56.45% reduction in road crashes was perceived by users in Kerala's Kazhakkoottam-Adoor model safe corridor, with crash data reductions ranging from 10–58% for various cost-effective solutions (Published in IRC Highways Journal).
- **All-weather road markings:** A 3M internal study on NHAI Vadakkanchery-Walayar Highway showed a 27% decrease in HMV runoff, 16% in LMV runoff, 1.49× improved lateral clearance, and 2.83× increased preview distance, ensuring better night and adverse weather visibility.
- **Vehicle Conspicuity Tape Effectiveness (SVNIT Study):** Revealed that some market-available tapes fail to meet AIS 090 reflectivity standards, emphasising the urgent need for strict enforcement of quality assurance measures to enhance vehicle safety.

3M is advocating standardised, high-performance road infrastructure, urging stronger enforcement of road sign quality, road marking durability, and vehicle safety tapes to reduce two-wheeler fatalities, which accounted for 45% of road crash deaths in 2022.

Key benefits:

- 56.45% crash reduction with better road signs and traffic furniture
- All-weather road markings improving lane discipline and reducing accidents
- Better vehicle visibility through compliant and high-performance conspicuity tapes
- Smart Variable Message Signs (VMS) for real-time traffic, weather, and emergency updates
- Government-industry collaboration for research, implementation, and awareness programmes

By integrating these targeted interventions and collaborating with MoRTH, NHAI, IITs, and industry partners, 3M is committed to creating safer, more resilient roadways across India.

Qualcomm

Industry sector: Tech and embedded IoT solutions for automotive and allied industries

Road safety initiative: Advanced Connected Vehicle Safety

Initiative overview:

Qualcomm's Snapdragon Digital Chassis provides a comprehensive platform for connected vehicle solutions, enabling auto OEMs to integrate real-time data sharing and GPS-based tracking into their vehicles. This solution supports government-led initiatives in Intelligent Transport Systems and V2X technologies, ensuring rapid emergency response and improved traffic management. By connecting vehicles with each other and with infrastructure, the platform enhances road safety, making transportation systems smarter and more responsive to potential hazards.

Key benefits:

- Faster emergency response through real-time GPS tracking.
- Improved hazard detection and prevention via data sharing.
- Enhanced connectivity between vehicles and road infrastructure.
- Support for government ITS and V2X initiatives, leading to safer roads.
- Overall improvement in traffic management and driver safety.

Microsoft

Industry sector: IT and Tech

Road safety initiative (1/3): Predictive forecasting, safer driving with Bosch

Initiative overview:

Bosch has developed a Predictive Road Condition Service that enhances road safety by integrating real-time road weather data with vehicle sensor inputs. Unlike traditional weather forecasts, this solution leverages data from a continuously driving reference fleet equipped with advanced road condition sensors. The system provides real-time information and warnings to vehicle infotainment and driver assistance systems, helping both human and automated vehicles anticipate and respond to hazardous road conditions such as ice, wet surfaces, and damage. To scale globally, Bosch required a platform capable of processing large volumes of data quickly and delivering actionable insights to vehicles in real-time.

Key benefits:

- Enables automated vehicles to better predict and react to road conditions, reducing accident risks.
- Provides real-time warnings to infotainment systems, improving driver awareness and response times.
- Uses sensor-equipped reference fleets to continuously collect and analyse road condition data.
- Designed to process and deliver large-scale road weather insights for global adoption.
- Helps vehicles adapt to changing conditions, improving traction, stability, and overall driving efficiency.

Road safety initiative (2/3): Enhancing Public Safety with In-Car Automated License Plate Recognition with Axon

Initiative overview:

Axon, a leader in public safety technology, has integrated real-time Automated License Plate Recognition (ALPR) into its Fleet 3 in-vehicle video solutions. This AI-powered system enables law enforcement and public safety agencies to automatically detect and identify vehicles of interest, such as those associated with missing persons, stolen vehicles, or criminal investigations. Leveraging Microsoft Azure, the solution processes vast amounts of data in real time, allowing officers to receive instant alerts and take appropriate action. By embedding machine learning models directly into in-car cameras, Axon ensures continuous, on-the-go analysis without the need for constant cloud connectivity.

Key benefits:

- Real-time identification of wanted vehicles helps officers act immediately.
- Supports investigations related to missing persons, stolen vehicles, and security threats.
- Machine learning models improve recognition accuracy and reduce false alerts.
- Runs directly on in-car devices, ensuring real-time performance with minimal latency.
- Uses Microsoft Azure to enhance data processing and expand coverage across multiple jurisdictions.

Road safety initiative (3/3): Ensuring Road Safety with Real-Time Weather Data with Azure

Initiative overview:

The Slovak Hydrometeorological Institute (SHMÚ) partnered with SOFTEC, a Microsoft Gold partner, to enhance road safety through advanced weather monitoring and predictive analytics. Given the high costs of traditional weather stations—up to €70,000 per unit—the initiative leveraged Microsoft Azure to process real-time weather and road condition data. This digital approach allowed for proactive road maintenance, enabling authorities to anticipate hazardous conditions and deploy resources more efficiently. By shifting from reactive to preventive maintenance strategies, the project significantly improved road safety while optimizing operational costs.

Key benefits:

- Authorities can take preventive action before adverse weather conditions arise.
- Reduces reliance on expensive traditional weather stations while lowering maintenance costs.
- Optimised salt usage, reducing environmental damage and resource wastage.
- Real-time weather and road condition insights improve decision-making.
- Cloud-based infrastructure ensures flexibility and rapid deployment across regions.

Autodesk India

Industry sector: 3D Design & Engineering

Road safety initiative: Enhancing Road Safety with Autodesk's Advanced Technology Solutions

Initiative overview:

Autodesk leverages its advanced design and technology solutions to improve road safety through AI-driven traffic management, connected vehicle systems, and intelligent road design. By integrating software like Civil 3D, InfraWorks, and BIM (Building Information Modeling) with real-time data analytics, Autodesk enables optimised traffic flow, reduced accident risks, and safer road infrastructure. Their initiatives include targeted pilot projects focused on improving road design, monitoring driver behavior, and implementing innovative safety measures for two-wheeler users. These solutions address global road safety challenges while supporting sustainable and resilient infrastructure development.

Key benefits:

- AI-driven solutions analyse traffic patterns to reduce congestion, minimise collision risks, and improve overall traffic flow.
- Advanced road design tools like Civil 3D and InfraWorks enable better road slopes, drainage systems, and intersection designs, reducing the likelihood of accidents.
- Connected vehicle systems and intelligent signages provide real-time alerts, helping drivers respond to potential hazards promptly.
- Dedicated lanes, optimised intersections, and targeted simulations prioritize the safety of vulnerable road users.
- Integration of BIM and GIS supports efficient project planning, resource optimisation, and scalability of safety measures.
- Real-time data sharing and simulation capabilities help identify high-risk areas, facilitating proactive interventions and efficient emergency response.

3.8 Tech initiatives taken in India to improve road safety

Technology has revolutionised road safety in many Indian cities, from recognising vehicle number plates to using drones for blind spots and crowd management, offering benefits like speed analysis and real-time alerts.

- In addition to the Integrated Road Accident Database (iRAD) for recording accident details, authorities use **analytics and on-ground data** to identify accident-prone areas. This approach has led to **reduction in road fatalities** in 2023, with dashboards providing insights into factors like age and fatality timings.
- Punjab has adopted the **Mappls app to provide real-time alert**s on black spots and traffic updates, becoming the first state in India to map all its black spots to enhance road safety and traffic management.
- The use of technology has significantly improved road safety in India. For instance, the Yashwantrao Chavan Expressway between Mumbai and Pune experienced a **40% reduction in fatalities** from 2016 to 2022 due to electronic enforcement and other tools. Additionally, data from iRAD has enabled the Tamil Nadu state government to **decrease road crash deaths by 2.8%** between 2018 and 2022.
- The Government of India is enhancing road safety through the **Advanced Traffic Management System** (ATMS) on high-density corridors and National Highways, in line with the Motor Vehicles (Amendment) Act, 2019. The National

Highways Authority of India (NHAI) has deployed ATMS on key expressways, improving incident detection and highway monitoring. On 10 October 2023, NHAI updated the ATMS standards to include **AI-based Video Incident Detection and Enforcement Systems** (VIDES) and **API-based e-challan issuance**, integrated with platforms like Rajmarg Yatra and NHAI One for real-time camera feeds to enforcement agencies.

- Government policies and regulations are essential in promoting technological adoption. Initiatives such as the National **Intelligent Transport Systems** (ITS) policy and partnerships with technology companies are positive steps forward.
- **Yulu:** India's shared electric mobility company has introduced the nation's first **WhatsApp-based Road Safety Learning Initiative** for delivery riders. This initiative, launched on the company's platform, has engaged over **3,600 Yulu riders** who have completed the first module, which includes basic traffic rule education and a quiz, earning them 'Safe Rider Beginner' badges.
- **Mercedes-Benz:** Mercedes-Benz Research and Development India (MBRDI) has significantly advanced road safety in India through its Accident Research team, specialising in accident reconstruction, data analytics, and anonymisation. The team employs cutting-edge technologies like d**eep learning-based image anonymisation, augmented reality with VuZix smart glasses, and Python-based data analysis** to enhance efficiency and privacy. Additionally, innovations such as **e-Call data** for precise accident tracking and Scaniverse 3D scanning improve accident scene analysis, contributing to the vision of accident-free mobility by 2050.
- **NHAI-IIIT:** The National Highways Authority of India (NHAI) has entered into a Memorandum of Understanding (MoU) with the Indraprastha Institute of Information Technology (IIIT) Delhi, a technical university established by the Government of National Capital Territory (NCT). This partnership aims to utilise **Artificial Intelligence (AI) to enhance the availability and condition of road signs** on National Highways spanning approximately 25,000 kilometers.

3.9 Strengthening emergency response and funding

Real-time data sharing and integrated trauma response

Strengthening emergency response requires real-time data sharing, GPS-enabled ambulances, and integrated trauma care systems to ensure faster, more efficient medical assistance. By leveraging smart technology, AI-driven dispatch systems, and centralised emergency networks, accident victims receive timely care, significantly improving survival rates. Seamless integration with traffic management, hospitals, and first responders ensures swift medical intervention. Countries with advanced emergency protocols showcase 30–40% faster response times, highlighting the potential of technology-driven trauma systems in reducing fatalities and long-term injuries.

Capacity building through bystander training and trauma care networks

Empowering citizens through bystander training and trauma care networks is critical to enhancing pre-hospital care. As per MoRTH, 50% of road fatalities could have been avoided if medical attention was given in the first hour. Programmes like basic first aid training, trauma response workshops, and community-led safety initiatives create a network of immediate responders. Collaboration with health institutions, Red Cross, and NGOs can ensure that millions of drivers, commuters, and law enforcement personnel are equipped to handle emergencies, bridging the crucial gap between accident occurrence and professional medical intervention.

Innovative funding models for emergency response and road safety

Sustainable funding models are essential for building robust emergency response systems and road safety infrastructure. Governments can explore public-private partnerships, insurance-linked models, and dedicated safety funds to ensure continuous investment in trauma care. Countries like the US and Sweden leverage insurance-driven emergency response models, ensuring seamless coverage for accident victims. Corporate contributions, CSR initiatives, and safety bonds can further enhance funding for GPS-based ambulance networks, trauma centres, and road safety education, ultimately reducing the economic burden of road accidents on healthcare systems.

04

Recommendations for government-industry collaboration

Scaling AI-based interventions from pilots to national programmes:

Advanced technologies such as predictive analytics, automated traffic management, and real-time monitoring have shown great potential in improving road safety. Government and industry must collaborate to integrate these solutions into national road safety programmes. This includes expanding smart traffic management systems, automated enforcement mechanisms, and data-driven accident prevention strategies. Public-private partnerships (PPPs) can help bridge funding gaps, while standardised data-sharing protocols and regulatory frameworks will be key to ensuring seamless, nationwide implementation.

Developing pilots for two-wheeler safety:

With nearly 45% of road fatalities in India involving two-wheeler users, targeted safety interventions are critical. The government may partner with industry leaders to develop and test pilots focusing on helmet compliance, vehicle conspicuity enhancements, and advanced braking systems. AI-driven solutions, such as rider behaviour monitoring and collision warning systems, can significantly reduce accident risks. Additionally, encouraging the use of high-visibility safety gear and reflective vehicle marking tapes should be tested and evaluated. These pilots can serve as blueprints for countrywide policies, ensuring safer mobility for two-wheeler users.

Updating Motor Vehicles (Amendment) Act, 2019 for new technology requirements:

The Motor Vehicles (Amendment) Act, 2019, may be updated to accommodate emerging road safety technologies. With advancements in connected vehicles, autonomous driving features, and ADAS (Advanced Driver Assistance Systems), regulations must ensure seamless adoption while maintaining safety standards. Industry stakeholders, including automakers, technology providers, and regulatory bodies, may be encouraged to collaborate to define clear guidelines for integrating new technologies. This includes mandating features like AI-enabled braking systems, electronic stability control, and smart dashboard warnings. Updating the Act will encourage innovation while ensuring uniform safety standards across all vehicle categories.

Integrating emergency care systems with tech-enabled ambulance networks:

Timely emergency response is crucial in reducing road accident fatalities. A well-integrated system connecting ambulances, hospitals, and traffic management centres can significantly improve outcomes. Governments should work with industry players to develop a national emergency care framework that leverages real-time GPS tracking, AI-based route optimisation, and smart traffic signal prioritisation for ambulances. Automated crash detection systems in vehicles can instantly alert emergency services, reducing response times. Additionally, partnerships with healthcare providers can ensure seamless coordination between accident sites, paramedics, and trauma centres. A robust emergency care ecosystem will save lives and enhance overall road safety resilience.

Grants and Innovation challenges for road-safety solutions:

Encouraging startups and tech innovators to develop road-safety solutions can accelerate the adoption of advanced interventions. The government may introduce targeted grants, funding programmes, and challenge-based hackathons to crowdsource new ideas. These initiatives can focus on AI-powered traffic monitoring, smart road infrastructure, predictive accident analytics, and vehicle safety enhancements. Additionally, regulatory sandboxes should be created, allowing startups to test new technologies in controlled environments before large-scale deployment. Collaboration with research institutions, industry players, and government agencies will ensure that the most promising innovations transition from concept to real-world implementation, ultimately reducing road fatalities.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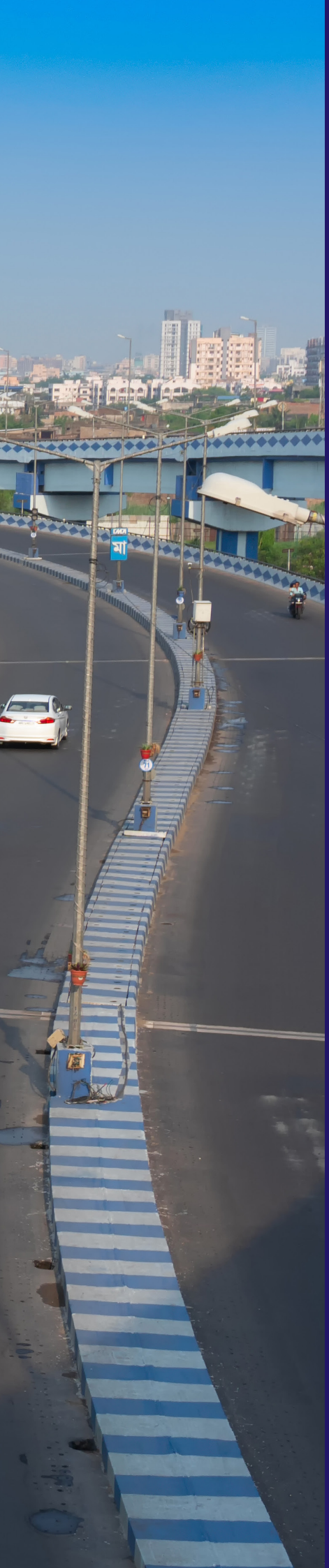

Conclusion

Road safety remains a critical global challenge, requiring a technology-driven, policy-backed, and multi-stakeholder approach to reduce fatalities and injuries. This report has underscored the importance of AI-driven traffic monitoring, enhanced signage and road markings, vehicle safety advancements, emergency care integration, and robust enforcement mechanisms in mitigating road accidents. These interventions, supported by collaborations between governments, industry players, and research institutions, are essential to building a safer and more efficient mobility ecosystem.

Case studies from global initiatives demonstrate the effectiveness of targeted road safety interventions. Intelligent Transport Systems (ITS) have significantly improved real-time traffic management, reducing congestion and accident-prone zones. Advanced Driver Assistance Systems (ADAS) and collision avoidance technologies have played a key role in minimising human error-related crashes, particularly rear-end and pedestrian collisions. Implementing high-visibility road markings and interactive road signage has enhanced night-time visibility and driver awareness, reducing accident risks in critical zones. Meanwhile, Vehicle-to-Everything (V2X) communication technologies have enabled early hazard detection, allowing drivers and emergency responders to react swiftly, further preventing collisions. Additionally, GPS-enabled ambulances and AI-based route optimisation have improved emergency response times, ensuring more lives are saved in post-crash situations.

While these advancements highlight significant progress, strengthening governance, accountability, and policy enforcement remains crucial. Governments must mandate and standardise emerging vehicle safety technologies, such as electronic stability control, fatigue monitoring, and AI-powered braking systems. More stringent post-crash response measures need to be established, to ensure victims receive coordinated emergency care and legal protection. Additionally, corporate and start-up-driven road safety innovations should be incentivised through regulatory sandboxes and targeted funding programmes. Traffic law enforcement needs to be strengthened through AI-based monitoring systems, ensuring compliance with helmet and seat belt mandates, speed regulations, and impaired driving deterrents.

The future of road safety will be significantly influenced by global partnerships, particularly the collaboration between the US and India. Both countries have the opportunity to jointly drive innovation in road safety technologies, leveraging the US's expertise in automated enforcement, ITS, and trauma care models alongside India's rapid urbanisation and digital infrastructure advancements. A structured collaboration can facilitate joint R&D efforts on AI-powered traffic management, vehicle safety enhancements, and predictive analytics for accident prevention. Furthermore, harmonisation of safety regulations and policy frameworks can establish globally aligned standards, fostering a more unified approach to road safety. Industry-driven partnerships will be crucial in accelerating the development of intelligent road infrastructure, connected mobility solutions, and data-driven enforcement mechanisms.

By treating road safety as a shared responsibility, nations can work towards a future with reduced road fatalities. With continued investment in advanced technologies, policy enforcement, and global cooperation, the vision of sustainable and safer mobility can become a reality. Through US-India collaboration and broader international partnerships, road safety solutions can be scaled effectively, ensuring safer roads for future generations.

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