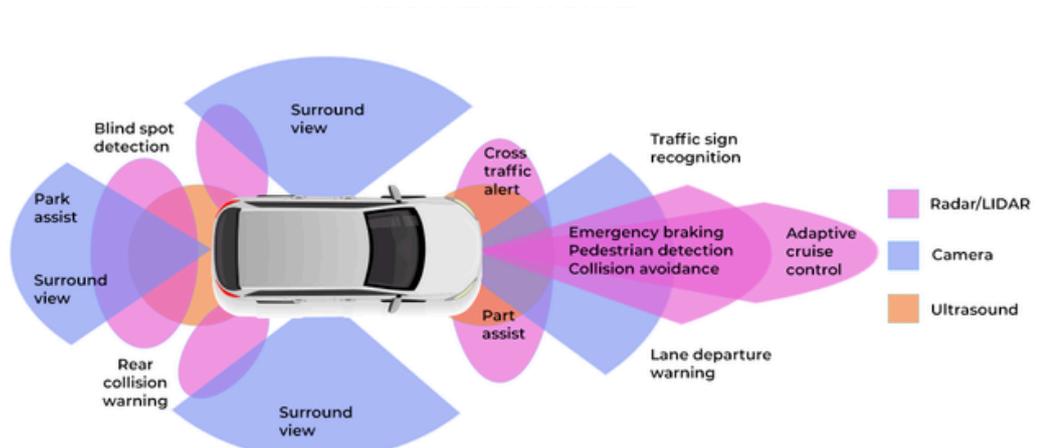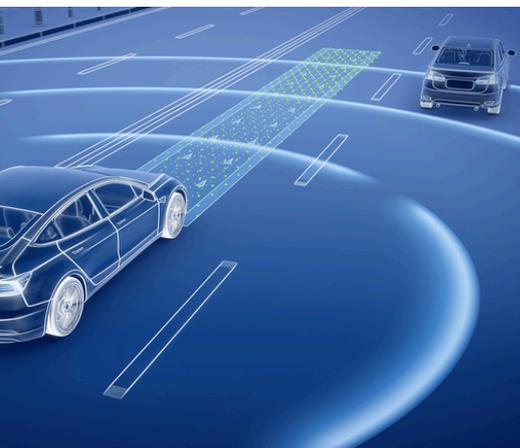# Enhancing Road Safety in India: Advanced Driver Assistance Systems (ADAS) as a Game-Changer

PREPARED BY:
ITS INDIA FORUM

Acknowledgement

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Executive summary

India's road safety crisis demands immediate attention, with over 460,000 accidents and more than 168,000 fatalities recorded in 2022 alone. Driver behaviour accounts for 84% of these incidents, emphasizing the urgent need for innovative solutions. The Advanced Driver Assistance Systems (ADAS) represent a transformative technology capable of significantly reducing accidents, enhancing driver behavior, and saving billions in public and private costs.

As a champion voice for intelligent transportation, the ITS India Forum has been at the forefront of advocating for ADAS adoption. By leveraging global best practices and tailoring solutions to India's unique road conditions, the Forum has worked tirelessly to create a roadmap for integrating ADAS across vehicle categories. Their proactive engagement with policymakers, industry leaders, and civil society has led to actionable recommendations that align with India's ambitious road safety goals.

This white paper encapsulates the ITS India Forum's vision for a safer India. It highlights how ADAS, supported by regulatory frameworks, funding mechanisms, and industry collaboration , can drastically reduce fatalities and create sustainable, accident-free roads. Case studies from cities like Nagpur and Hyderabad serve as testaments to the efficacy of ADAS technology when implemented strategically.

With a phased adoption strategy starting in 2025, this document advocates for a comprehensive rollout of ADAS, supported by public-private partnerships, CSR funding, and insurance reforms. By championing intelligent mobility solutions, the ITS India Forum is not just addressing today's road safety challenges but laying the foundation for a future where every journey is safer and more efficient.

Introduction

Context

India faces a significant road safety crisis, characterized by an alarming number of road accidents and fatalities each year. In 2022 alone, over 460,000 accidents were reported, leading to more than 168,000 fatalities. The majority of these incidents—around 84%—are attributed to Driver behaviour, including distracted driving, speeding, fatigue, and poor decision-making.

Urban areas account for approximately 60% of these accidents due to high vehicle density, complex road networks, and frequent interactions between vehicles, pedestrians, and cyclists. Meanwhile, rural areas, which contribute to 40% of accidents, grapple with challenges like inadequate road infrastructure, high-speed collisions, and limited law enforcement presence.

Despite advancements in vehicle safety features and road infrastructure, India's road safety metrics remain a critical concern. The economic and social costs of road accidents—ranging from healthcare expenses to productivity losses—underscore the urgency of finding effective solutions.

This white paper introduces Advanced Driver Assistance Systems (ADAS) as a transformative technology capable of addressing these challenges. By leveraging features such as collision avoidance, lane-keeping assistance, and driver monitoring systems, ADAS can significantly reduce the impact of human errors and enhance road safety.

The ITS India Forum advocates for the phased adoption of ADAS technologies, emphasizing their potential to revolutionize road safety in India. Through strategic implementation, supported by public-private partnerships, regulatory frameworks, and funding mechanisms, ADAS has the potential to save thousands of lives annually and create safer road environments across the country

Objective

This paper evaluates the role of ADAS in mitigating road accidents and human error while proposing a phased implementation strategy to make Indian roads safer. This discusses why conventional road safety methods have failed and proposes a new approach – Road Safety 2.0, which is:

- Data-driven, integrated, collaborative, and digital.
- Emphasizes that automated transport systems are the safest.
- Advocates for technology-based solutions to identify accident-prone areas, monitor driver behavior, and improve enforcement.

Understanding Road Safety Challenges:

- Identifying key factors contributing to road accidents and fatalities, such as urban congestion, poor rural infrastructure, and behavioral risks.

- Analyzing accident statistics to highlight areas of concern and prioritize interventions.

Exploring ADAS Technologies:

- Detailing the features of ADAS, such as collision avoidance systems, lane-keeping assistance, adaptive cruise control, and driver monitoring systems.

- Examining how these technologies improve driver behaviour and enhance road safety.

- Providing real-time alerts for accident-prone zones and reckless driving.

- Identifying good and bad drivers objectively using AI-driven Safe Driving Scores (SDS).

- Enhancing enforcement through real-time evidence collection.

- Scaling awareness efforts using digital platforms for education and outreach.

- Making safety solutions cost-effective and democratic for widespread adoption.

Case Studies and Real-World Applications:

- Presenting success stories of ADAS implementation in cities like Nagpur, Hyderabad, and Mumbai to showcase its impact on accident reduction and policy improvements.

- Highlighting specific initiatives tailored to India's unique road conditions and challenges.

Implementation Strategies:

- Proposing phased adoption timelines and funding mechanisms for integrating ADAS into various vehicle categories, including two-wheelers, four-wheelers, and commercial vehicles.

- Exploring public-private partnerships and regulatory measures to support adoption.

- Collision Warning & Automatic Braking (ADAS): Reduces rear-end collisions by 50-60%.

- Lane Departure Warning & Lane-Keep Assist (LKA): Decreases lane-change accidents by 30-50%.

- Blind Spot Detection (BSD): Lowers crashes by 14%.

- Speed Alerts & Driver Monitoring Systems (DMS): Cuts speed-related accidents by 30-40%.

- Vehicle-to-Everything (V2X) Communication: Prevents up to 80% of crashes involving unimpaired drivers (NHTSA studies).

Economic and Social Impacts:

- Quantifying the potential savings in accident-related costs, insurance premiums, and healthcare expenditures.

- Assessing the broader societal benefits, such as reduced fatalities, improved public safety, and enhanced productivity.

Recommendations for Policymakers:

- Offering actionable recommendations for a comprehensive ADAS adoption strategy.

- Identifying areas where collaboration between government, industry, and civil society can drive innovation and implementation.

Advanced Driver Assistance Systems (ADAS)

Introduction to ADAS

Advanced Driver Assistance Systems (ADAS) are a suite of technological tools designed to enhance road safety by mitigating human errors, which account for approximately 84% of road accidents in India. These systems leverage sensors, cameras, and AI technologies to monitor vehicle surroundings, assist drivers in various tasks, and alert them to potential hazards.

Given India's high rates of road accidents and fatalities, ADAS has the potential to transform road safety by addressing the behavioral and infrastructural challenges contributing to accidents.

Road Safety Statistics in India

To understand the critical role of ADAS, it is essential to contextualize India's road safety scenario:

Year	Road Accidents	Fatalities	Notes
2023 (Preliminary)	~Stable compared to 2022	Estimated similar trend to 2022	Official report pending; early indications show continuing high fatality rate.
2022	461,312	168,491	9.4% increase in fatalities from 2021, with speeding as a major cause, contributing to over 70% of deaths.
2021	412,432	153,972	Increase in road activity and incidents after COVID-19 lockdowns.
2020	366,138	131,714	Reduced accidents and fatalities due to COVID-19 restrictions and lower traffic levels.
2019	449,002	151,113	High fatality rate prior to the pandemic.
2018	467,000	151,417	Significant incidents on national and state highways.

Road Accident and Fatalities Trend
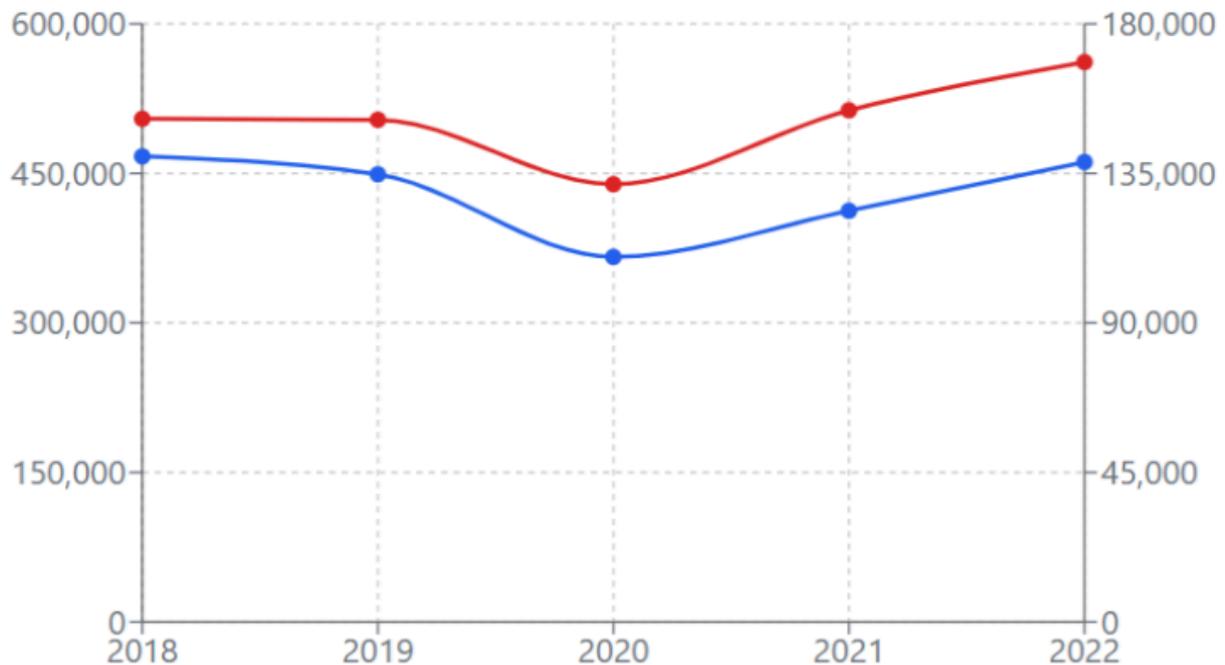
Key Insights

Total Accidents: The data shows a fluctuating trend in the number of accidents, with a significant rise in 2022, marking more than 461,000 road accidents reported.

Total Fatalities: In 2022, over 168,000 fatalities were recorded, emphasizing the severity of road safety issues in India. This represents alarming statistics about road fatalities in India, highlighting that the country has the highest number of road crash-related deaths worldwide:

- 2021: 1,53,972 fatalities (NCRB India).
- 2022: 1,68,471 fatalities (NCRB India).
- 2023: Over 172,000 fatalities, showing a year-on-year increase of nearly 10%, while globally, road fatalities have decreased by 5%.
- This data underscores the urgent need for better road safety measures and advanced technologies

Urban vs. Rural

Urban areas contribute significantly to the total number of accidents, reflecting the need for targeted road safety measures in densely populated regions

Accident Distribution by Area (2022)

1. Urban Areas

   High vehicle density

   Congested roads

   Frequent pedestrian and cyclist interactions

2. Rural Areas:

   Poor road infrastructure

   Higher speed limits on less congested road

   Limited law enforcement presence

Urban vs. Rural Trends

a. Accidents: Approximately 200,000 (40% of total accidents)

b. Fatalities: About 50,000 (34% of total fatalities)

Characteristics:

- Urban Areas: Account for 60% of accidents and 66% of fatalities due to high vehicle density, congested roads, and frequent pedestrian interactions.

- Rural Areas: Contribute to 40% of accidents and 34% of fatalities, largely due to poor infrastructure, higher speed limits, and limited law enforcement.
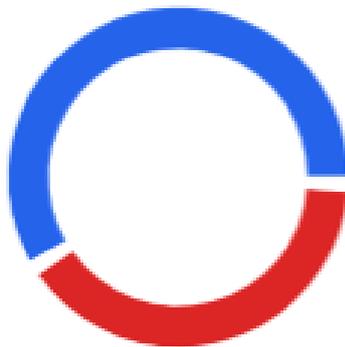
● Urban (60%)   ● Rural (40%)

Fatalities Distribution

Mitigating Human Errors

ADAS addresses the most common human errors contributing to accidents:

- **Collision Avoidance Systems**: Reduce accidents by alerting drivers to potential collisions, speeding, maneuvering, tailgating, changed weather conditions, traffic rules violations and applying automatic braking if necessary.

- **Driver Monitoring Systems**: Detects signs of fatigue, drowsiness, mobile phone usage or distraction, improving alertness.

- **Adaptive Cruise Control (ACC)**: Ensures safe following distances, reducing rear-end collisions.

Enhancing Safety in Urban Areas

In urban settings, where 60% of accidents occur, ADAS technologies can:

- Manage high traffic density with smart traffic signal integration.

- Improve pedestrian safety through automated braking and pedestrian detection systems.

- Prevent congestion-related incidents via lane-keeping assistance and blind spot detection.

Addressing Rural Road Challenges

For rural areas, ADAS contributes to:

- Mitigating high-speed collisions with adaptive speed controls.

- Improving driver visibility and decision-making on poorly lit roads with advanced lighting systems and night vision assistance.

How ADAS Addresses Road Safety Challenges

Implementation of ADAS for Road Safety

Immediate Benefits

- Accident Reduction: Studies show that ADAS can reduce accidents by 30–50% when fully adopted.

- Fatality Mitigation: Features like collision avoidance and lane-keeping systems are critical for reducing fatalities caused by human errors.

Long-term Impacts

- Behavioral Change: Encourages safe driving habits through driver monitoring and real-time alerts.

- Economic Savings: Reduces the financial burden of accidents on healthcare and insurance systems.

Types of Advanced Driver Assistance Systems (ADAS)

1. ADAS for Two- and Three-Wheelers

Overview: Traditionally associated with four-wheelers, ADAS technology is now being adapted for motorcycles and scooters. With higher accident vulnerability and increasing urban congestion integrating ADAS into two- and three-wheelers offers unique challenges and opportunities.

Key Features:

Feature	Description
Driver Scoring System	-Analyze every second of driving and calculation of Driving Score by the sophisticated AI algorithms-Positive scoring for displaying good driving practices: This leads to change in the driving behavior in long-run
Collision Avoidance	Alerts riders to potential collisions using sensors and cameras.
Lane Keeping Assistance	- Lane Departure Warning: Alerts the rider if they unintentionally drift out of their lane.- Active Lane Keeping: Adjusts steering to help the rider remain in the lane.
Adaptive Cruise Control	Adjusts the speed to maintain a safe distance from the vehicle ahead, enhancing comfort during long rides.
Blind Spot Detection	Monitors blind spots, alerting riders to nearby vehicles, particularly useful in urban traffic.
Traction Control Systems	Prevents wheel slip during acceleration by adjusting power delivery, enhancing stability.
V2V and V2I Communication	Enables communication with other vehicles and infrastructure, improving situational awareness.
Rider Monitoring Systems	Monitors rider behavior and alertness, providing warnings for fatigue or distraction.

Challenges:

Challenge	Details
Space Constraints	Compact design limits space for sensors and systems, requiring innovative solutions.
Cost Considerations	Riders often prioritize affordability, necessitating cost-effective ADAS solutions.
Riding Dynamics	Tailoring ADAS for the unique dynamics of two- and three-wheelers is complex.
User Acceptance	Educating riders about ADAS benefits is critical for widespread adoption.

Case Studies:

Project	Objective	Impact
Honda Motorcycle Assist Technology	Improve stability and prevent accidents.	Reduced low-speed accident rates and enhanced rider confidence in crowded urban areas.
Bosch ARAS for Two-Wheelers	Adapt car-based ADAS technology for motorcycles.	30% reduction in high-speed collision risks through adaptive cruise control and warnings.
TVS ADAS for Indian Roads	Tailor ADAS features for urban traffic conditions.	25% improvement in accident prevention during urban trials in Bangalore.
Hero MotoCorp's V2X for Three-Wheelers	Introduce AI-based V2X communication for shared vehicles.	20% reduction in accident rates and enhanced safety for fleet operators.

2. ADAS for Four-Wheelers and Larger Vehicles

Overview: Essential for enhancing safety and reducing accidents, ADAS for four-wheelers and larger vehicles caters to public, private, and commercial transportation sectors.

Key Features:

Feature	Description
Collision Avoidance Systems (CAS)	Forward Collision Warning (FCW): Alerts drivers to potential front-end collisions.Automatic Emergency Braking (AEB): Applies brakes automatically to prevent or mitigate impacts.
Lane Assistance Systems	Lane Departure Warning (LDW): Alerts for unintentional lane drifts.Lane Keeping Assist (LKA): Corrects vehicle path to maintain lane.
Adaptive Cruise Control	Maintains a safe distance from vehicles ahead, adjusting speed automatically.
Blind Spot Detection (BSD)	Monitors areas adjacent to the vehicle, reducing side-impact collisions.
Parking Assistance	Automated Parking Assist: Guides the vehicle into parking spots.360-Degree Camera Systems: Provides a bird's-eye view for tight spaces.
Traffic Sign Recognition	Detects and displays critical road signs like speed limits and warnings.
Driver Monitoring Systems	Monitors driver behavior, issuing alerts for drowsiness or distraction (mobile phone usage) or even seat belt compliance.

Challenges:

Challenge	Details
Complexity and Cost	Advanced features like radar and LIDAR increase costs, affecting affordability.
Maintenance Requirements	Regular calibration is needed, especially for heavy-duty vehicles operating in harsh conditions.
Driver Training	While technology has the option to automate driver trainings basis their own driving pattern, eEducating drivers about ADAS features is essential for effective adoption.
Infrastructure Dependence	V2V and V2I rely on smart infrastructure, which may not be uniformly available.

Case Studies:

Project	Objective	Impact
Tata Motors' ADAS for Indian Roads	Adapt ADAS for India's unique traffic conditions.	Improved safety and effectiveness on roads with minimal lane markings.
Mahindra XUV700 ADAS	Enhance driver comfort and safety on highways.	Addressed fatigue and congestion issues during long routes.
Indian Institute of Science, Zoom Car and Netradyne studyLink	Influence driver behavior through 500 Zoom cars that completed 52000 trips covering 10.6 million miles and 5 lakh driving hours	51% reduction in speeding behavior, 14% lesser accidents in cars with voice activated alerts, and 27% decline in 6 of the 20+ driving metrics (including hard braking, collision warning, etc.)
Writer Safeguard, A Hitachi Group Cash Management companyLink	Enhance driver & van safety standards, and reduce unsafe driving practices	Reduction of 50% in road accidents, 74% in drowsiness instances, 38% in distracted driving instances
IndianOil Skytanking and ShellLink (IOSL)	Elevate safety standards, automate driver coaching, centralized fleet safety management	Implementation of global safety standards, deep analytics on driver behavior available centrally
Volvo Trucks' Active Driver Assist	Increase safety in commercial trucking.	Significant reduction in rear-end collisions and improved driver confidence.
Tesla Autopilot for SUVs and Trucks	Semi-autonomous driving capabilities.	Enhanced accident prevention and driver convenience on compatible roads.

Future Prospects for ADAS:

Aspect	Details
Advancements in AI	Improved algorithms and sensor technologies will make ADAS more effective and affordable.
Legislation and Standards	Governments are mandating ADAS features, accelerating adoption and driving innovation.
Autonomous Driving Evolution	ADAS serves as a precursor to fully autonomous vehicles, enhancing safety and efficiency.
Most accurate information on the reason of the road accident	-With video footages available on cloud, investigation agencies will have the view of real proof behind every accident – identifying culprits, removing the guess-work.-Indian's road accident report & eDAR data will be based on real inputs versus the accident data which is based on driver's or on-looker's feedback.
Identification of Black or Grey Spots	With vehicles capturing every road of the country, identification of black and grey spots can be supported by the technology
Better insurance management	Insurance providers can determine the real reason and process claims, that too faster. This shall also eliminate false claims.
Driving License Management	RTOs can approve renewal or cancel driving licenses basis the driver scoring.

Roadmap for ADAS Implementation in India

The proposed roadmap for the implementation of Advanced Driver Assistance Systems (ADAS) in India focuses on enhancing road safety through phased adoption, supported by innovative funding strategies and clear timelines.

Financial Implications of ADAS Implementation

The proposed roadmap for the implementation of Advanced Driver Assistance Systems (ADAS) in India focuses on enhancing road safety through phased adoption, supported by innovative funding strategies and clear timelines.

Financial Impact for Two-Wheelers

Category	Details
2023 Sales	15.86 million units
CAPEX	₹31,720 crore (₹2,000 per unit)
Operational Cost	₹23,790 crore (₹1,200 per unit)

Financial Impact for Four-Wheelers

Category	Details
2023 Sales	4.10 million units
CAPEX	₹6,150 crore (₹15,000 per unit)
Operational Cost	₹10,250 crore annually (₹2,500/month/unit)

Retrofit Costs for Older Vehicles

Category	Details
Two-Wheelers (Active 60%)	₹1,982 crore (7.93 million units × ₹2,500)
Four-Wheelers (Active 60%)	₹29,175 crore (19.45 million units × ₹15,000)

Proposed Funding Sources

1. Cross-Subsidy:

- Accident reduction from ADAS is projected to save ₹2,000 crore annually due to lower public and private exchequer payouts.
- 50% of this savings (₹1,500 crore) can be directed toward subsidizing ADAS adoption, covering capital costs effectively.

2. Reduction in Insurance Premiums:

- **Impact on Insurance Companies**: ADAS could reduce accidents by 30–40%, decreasing compensation payouts.
- **Vehicle Owners' Rebate**: Insurance companies can offer rebates on premiums, making ADAS affordable for consumers.
- **Driver Behavior Insights**: Safe driving scores from ADAS could inform personalized life insurance premium adjustments..

3. CSR Contributions by Vehicle Manufacturers:

- The Indian vehicle industry's **CSR budget** could allocate ₹75 crore annually (1% of ₹7,500 crore CSR obligations) to ADAS integration, offsetting CAPEX without burdening consumers.

Recommendations

The **ITS India Forum**, backed by extensive research and consultations, strongly recommends the following:

1. **Government Mandate:** Mandate the implementation of Advanced Driver Assistance Systems (ADAS), including Driver Monitoring Systems (DMS), for all vehicle categories in India to enhance road safety, reduce accidents, and promote responsible driving behavior**.**

2. **Bharat Rating Integration**: Incorporate ADAS compliance into the Bharat rating system to promote adoption.

3. **Standardization Support**: Develop standardized specifications for ADAS in collaboration with agencies like ICAR, ARRI, and ITS India Forum.

4. **Awareness Campaigns**: Launch campaigns to educate consumers on the benefits of ADAS and its role in improving road safety.

5. **Automated Enforcement Systems**: Using AI cameras, LiDAR, ANPR, and V2X technology to detect violations and issue automated penalties.

6. **Incentives for Safe Driving**: Offering lower registration fees and insurance premiums for drivers with high Safe Driving Scores (SDS) and vehicles equipped with ADAS and V2X technology.

7. **Encouraging Adoption of Safety Tech**: Promoting better vehicle safety standards by linking Bharat NCAP ratings with incentives.

8. **Opening e-DAR/IRAD Data for Innovators**: Allowing limited public access to road accident data to encourage startups, researchers, and young innovators to develop AI/IoT-based safety solutions.

9. **Tax Exemptions on Road Safety Equipment**: Reducing costs of helmets, airbags, seatbelts, sensors, and cameras to make safety tech more affordable.

10. **Production-Linked Incentive (PLI) Scheme**: Boosting local manufacturing of safety hardware and software, fostering innovation, and making India a hub for road safety technology.

Conclusion

By implementing ADAS across all vehicle categories, India can achieve a significant reduction in accidents and fatalities, leading to safer roads, economic savings, and improved public welfare. With phased timelines, innovative funding solutions, and collaborative efforts, the roadmap ensures both feasibility and sustainability for nationwide adoption of ADAS.

This proposal aligns with India's commitment to improving road safety and fostering a culture of responsible and technology-assisted driving.

To enhance road safety, a bottom-up approach focusing on drivers and vehicles is crucial. Implementing Safe Driving Scores (SDS)—an AI-based real-time system—can objectively track driver behavior and improve road safety. This system can lead to targeted training, rewards for good behavior, and penalties for poor driving habits.

Key statistics from studies and pilot projects show that:

- Collision Warning & Automatic Braking (ADAS) can reduce rear-end collisions by 50-60%.
- Lane Departure Warning (LDW) & Lane-Keep Assist (LKA) cut lane-change accidents by 30-50%.
- Blind Spot Detection (BSD) reduces crashes by 14%.
- Speed Alerts & Driver Monitoring Systems (DMS) lower speed-related accidents by 30-40%.
- Vehicle-to-Everything (V2X) Communication can prevent up to 80% of crashes involving unimpaired drivers (as per NHTSA studies).

Additionally, leveraging digital awareness campaigns over traditional methods can help scale road safety efforts more efficiently and cost-effectively. By focusing on real-time monitoring, awareness, and incentives, driver behavior can be transformed, leading to a significant reduction in road fatalities.

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