

**EVOLUTION OF ARTIFICIAL INTELLIGENCE IN PASSENGER VEHICLE
SAFETY: A SYSTEMATIC REVIEW (2005–2025)”**

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Abstract

The last twenty years have witnessed significant changes in passenger vehicle safety systems through Artificial Intelligence (AI) technology. AI technologies have developed from basic driver assistance systems to complete automated decision-making systems, which result in decreased human errors and improved road safety. This systematic review investigates the global development of AI safety technologies between 2005 and 2025 and their implementation in India. The study synthesizes findings from peer-reviewed journals, IEEE, Elsevier, Springer, and Scopus-indexed publications. The research document identifies the major technological development points and the active research fields and the existing safety protection systems. The review examines future research directions for AI-powered passenger vehicle safety systems in India.

1. Introduction

Artificial Intelligence has emerged as one of the most transformative technologies in the automotive sector. The evolution of vehicle safety has progressed from mechanical braking systems to intelligent decision-making systems through the development of AI technologies. Advanced driver assistance systems (ADAS) in modern passenger vehicles use machine learning and computer vision and sensor fusion technologies. The systems operate in two modes, which include driver assistance functions and functions that stop accidents from occurring. The global increase in road traffic has made intelligent safety systems more essential than ever before. AI technology is changing how vehicles recognize and handle their surrounding environment.

In the early 2000s, vehicle safety systems used reactive methods that required drivers to make decisions while using basic electronic stability control systems. The development of AI-based systems became possible when computer performance reached a higher level. The adoption of automatic emergency braking and lane departure warning technology became standard practice. The systems established the foundation which led to the development of active vehicle safety systems. The process of intelligent mobility transformation started through dedicated research efforts and financial support from different industry sectors. The technological evolution demonstrates the industry's transition from traditional methods to complete automation solutions.

The global automotive industry, including government agencies and car manufacturers, has made significant financial contributions to AI transportation research. The United States and Germany and Japan and China have emerged as the leading countries for developing autonomous driving technology. Regulatory authorities have created standards which require AI systems to meet safety requirements. The development of safety standards ISO 26262 and SOTIF addresses the potential dangers that intelligent systems present. The regulations established guidelines which ensure that AI technology development in passenger vehicles occurs according to responsible practices.

The process of Indian organizations adopting AI safety technologies has progressed at a steady pace over time. The automotive market first introduced AI technology in premium vehicle models. The increased consumer knowledge combined with government regulations, which

required ABS and airbags in all vehicles, led to more widespread adoption of these technologies. Indian manufacturers are now integrating advanced safety technologies to remain competitive in the global market. The government has established smart mobility initiatives, which will create an environment that supports AI innovation.

The increasing use of AI technologies in passenger vehicles has generated new research requirements about safety assessment and ethical issues and public trust problems. AI technology improves capacity to prevent car crashes, but there are ongoing concerns about system reliability and potential operational problems. The AI researchers develop methods, which help users understand AI results while gaining information about the technology's safety needs. The research field has established academic interest in studying how AI technology has progressed in vehicle safety systems.

2. Research Objectives

1. To examine the global evolution of AI in passenger vehicle safety (2005–2025).
2. To analyse AI-driven safety developments in India.
3. To review 25 significant peer-reviewed research contributions in the domain.
4. To identify research trends, gaps, and future directions.

3. Research Scope:

The study covers research publications between 2005 and 2025 focusing on AI applications in passenger vehicle safety. The collection includes articles that have received peer review, materials from IEEE conference proceedings, and publications that Elsevier and Springer and Scopus have indexed. The research focuses on passenger vehicles while excluding all types of heavy commercial vehicles from its scope. The study period includes both international and Indian advancements.

4. Research methodology or Research approach

The research uses a systematic review methodology for its entire study. Research papers were collected from databases such as Scopus, IEEE Xplore, ScienceDirect, SpringerLink, and Google Scholar. The search terms included "Artificial Intelligence in Vehicle Safety" and "ADAS" and "Autonomous Driving Safety" and "Machine Learning in Automotive Systems." The first stage included 120 selected papers, while 25 high-quality peer-reviewed papers were chosen for final selection based on their relevance and citation impact.

The selected studies were analysed thematically under categories such as perception systems, decision-making algorithms, sensor fusion, safety validation frameworks, and regulatory standards. The research used PRISMA guidelines to establish systematic screening methods which guarantee transparent results. Findings were organized in chronological order to demonstrate how technological advancements unfolded during two decades.

5. Global advancements in AI technology for passenger vehicle safety

In the mid-2000s, international markets first adopted AI technology through its incorporation into adaptive cruise control and stability control systems. The period from 2010 to 2015 saw major developments in computer vision and deep learning technologies which enabled object detection and pedestrian recognition capabilities. Tesla BMW and Toyota all advanced their development of semi-autonomous vehicles during this period. The post-2015 period saw the introduction of AI-based Level 2 and Level 3 automation systems which became available for commercial use.

The research after 2020 transitioned toward developing explainable AI systems, creating safety validation methods, and building ethical decision-making frameworks. Reliability improvement came through sensor fusion which integrated data from LiDAR systems and radar systems and camera systems. The introduction of advanced neural networks improved hazard detection capabilities which operate in real-time. The academic sector and industrial partners worked together to create new innovations through their international research partnership. The

AI safety research field will focus on three key areas which include building trust and providing transparent information and meeting regulatory standards by 2025.

6. AI technology for passenger vehicle safety in India

India uses AI technology for passenger vehicle safety in its automotive industry. The country established AI safety systems through its adoption of premium imported vehicle technology. Indian car manufacturers started adding reverse parking sensors and basic driver alerts between 2015 and 2020. The implementation of regulatory mandates resulted in better adoption of standard safety measures. Lawmakers began advocating for improved technology solutions because road accidents increased.

Indian automotive companies have started funding AI research partnerships since the year 2020. Sensor analytics products development together with predictive safety algorithm technology creation is being undertaken by startups. Government initiatives that support electric and smart vehicle development create pathways for businesses to incorporate AI technology. India is making progress toward intelligent passenger vehicle safety systems even though its adoption rate tracks behind Western countries.

7. The future of technology for Indian passenger vehicles

The future of Indian passenger vehicle safety will likely focus on affordable AI integration. Indian roads need cost-effective ADAS solutions which organizations will develop into essential future technologies. AI models trained on local traffic patterns will improve performance.

Advanced safety features will soon become mandatory through government regulations. The automotive industry will experience innovation through collaboration between IT and automotive engineering fields. AI technology will see more widespread use because of electric vehicle market growth in India. India has strong potential to emerge as a hub for AI-based automotive safety development.

The systematic review research project investigates how AI technologies developed between 2005 and 2025 to improve passenger vehicle safety. The study analyses international and Indian technological advancements while identifying gaps in research and forecasting future technological progress. The paper uses peer-reviewed literature to explain the existing state of AI automotive safety and the challenges that need to be resolved.

8. Literature Review:

A Systematic literature review was conducted The Literature Review section consists of 25 research papers which contain 5-line summaries as their content.

1. Davis (1989) The Technology Acceptance Model (TAM) developed by Davis describes how perceived usefulness and perceived ease of use lead to technology adoption. The theory provides a basis to understand how people accept AI-based safety systems in passenger vehicles despite its lack of direct application to automotive AI. Users adopt technology when they believe that it will enhance their performance according to the study results. AI systems must provide obvious safety advantages in order to meet vehicle safety requirements. Researchers use TAM as their framework to study how AI technology gets adopted in transportation systems.

2. Lee & See (2004) The researchers investigated how trust between people and machines develops through automation trust between humans and machines develops throughout their research. The study found that people need automated systems to deliver both predictable results and transparent operations to build their trust. Driver trust in AI-based vehicle features depends on these principles which govern passenger vehicle safety. The research also emphasized the balance between over-trust and under-trust in automation. The framework serves as a core element for conducting research on AI safety.

3. Thrun et al. (2006) The DARPA Grand Challenge provided the first testing ground for autonomous vehicles when Thrun and his research team demonstrated their first tests with self-

driving cars. Their work showcased AI-based perception, mapping, and navigation capabilities. The research demonstrated how artificial intelligence applications reached a new level of development in real-world driving environments. The research demonstrated that autonomous systems can use machine learning together with sensor data to achieve safe movement capabilities. The research established the foundation for current AI safety systems.

4. Paden et al. (2016) The researchers conducted a review of the motion planning and control systems which autonomous vehicles use to operate their vehicles. The study emphasized how predictive modeling combined with decision-making systems enables safe navigation throughout its entire duration. The research project demonstrated how predictive modeling combines with decision-making systems to achieve complete safe navigation throughout its entire duration through operational tests. The research project showed how predictive modeling systems function as decision-making systems which help researchers achieve safe navigation throughout their entire operational tests. The research project showed how predictive modeling systems function as decision-making systems which help researchers achieve safe navigation throughout their entire operational tests.

5. Bansal et al. (2016) Bansal and colleagues examined public opinion toward automated vehicles in the United States. The study revealed that safety improvement was the primary reason consumers supported automation. However, concerns about system failure remained. The findings stress the importance of reliable AI safety systems to gain public trust. Consumer perception plays a crucial role in technological evolution.

6. Nordhoff et al. (2016) Nordhoff et al. investigated user acceptance of driverless vehicles. Their research found that perceived safety and trust significantly influence adoption intention. Participants were more willing to use automated vehicles when safety benefits were clearly communicated. The study highlights psychological dimensions of AI integration. Safety perception remains a dominant adoption factor.

7. Kaur & Rampersad (2018) Kaur and Rampersad explored trust in driverless car technology. Their findings indicate that technical reliability and ethical clarity influence consumer confidence. The study emphasized that AI systems must be transparent in decision-making. It also identified cultural and demographic differences in trust levels. This research strengthened the theoretical link between AI safety and trust.

8. Zhang et al. (2019) Zhang and colleagues studied perceived risk and trust in automated driving technologies. Their findings revealed that perceived safety significantly reduces adoption resistance. The study demonstrated that trust mediates the relationship between risk perception and purchase intention. AI safety systems must therefore address risk-related concerns. This work supports trust-based safety models.

9. Yurtsever et al. (2020) Yurtsever et al. conducted a comprehensive survey of autonomous driving perception systems. The study detailed advancements in LiDAR, radar, and camera-based sensor fusion. It explained how deep learning improves object detection accuracy. Enhanced perception contributes directly to collision prevention. Their work highlights technical progress in AI safety mechanisms.

10. Madigan et al. (2017) Madigan and colleagues analyzed public willingness to use automated transport systems. The research confirmed that trust strongly predicts adoption behavior. Participants were more comfortable when AI systems demonstrated consistent performance. The study emphasizes that safety reliability shapes behavioral intention. Trust-building measures are essential for AI expansion.

11. Litman (2020) Litman examined long-term implications of autonomous vehicle deployment. The research predicted substantial accident reduction due to AI-driven safety mechanisms. However, it also cautioned about regulatory and ethical challenges. The study emphasizes that policy support is vital for safe AI integration. Long-term safety outcomes depend on structured implementation.

12. Fraedrich & Lenz (2014) Fraedrich and Lenz discussed societal implications of automated vehicles. Their research highlighted safety improvements alongside infrastructure challenges. They emphasized that automation reduces human error, which is a leading accident cause. However, public trust remains essential for widespread adoption. The study connects social acceptance with technological advancement.

13. Howard & Dai (2014) Howard and Dai studied consumer attitudes toward self-driving cars. They found that safety benefits increase positive perception, but fear of malfunction reduces trust. The study suggested transparent communication to improve acceptance. It also highlighted generational differences in perception. Safety assurance plays a key motivational role.

14. Tselentis (2023) Tselentis reviewed artificial intelligence applications in transportation safety analytics. The study found that AI models outperform traditional statistical crash prediction methods. Machine learning improves real-time hazard detection. This research demonstrates the analytical strength of AI in accident prevention. It supports data-driven safety management systems.

15. Nascimento et al. (2019) Nascimento conducted a systematic review on AI's impact on autonomous vehicle safety. The study identified verification and validation challenges in AI models. It emphasized the need for structured safety testing frameworks. Their findings underline the importance of regulatory alignment. AI safety requires continuous evaluation.

16. Butt & Shafique (2025) Butt and Shafique analyzed AI-based crash severity prediction models. Their research demonstrated improved predictive accuracy using machine learning algorithms. The study supports integration of predictive analytics into active safety systems. It shows how AI can reduce accident severity. Predictive safety is a growing research trend.

17. Wäschle et al. (2022) Wäschle and colleagues reviewed AI validation strategies for automated driving. They stressed the importance of simulation-based safety testing. The study highlighted challenges in verifying deep learning systems. Regulatory compliance is crucial for AI deployment. Safety assurance remains a primary concern.

18. Garikapati & Shetiya (2024) Garikapati and Shetiya examined the evolution of AI technologies in autonomous vehicles. Their review showed a shift from rule-based systems to deep learning architectures. The study emphasized innovation acceleration post-2015. AI-driven automation has significantly improved safety features. Continuous research is expanding AI capability.

19. Kuznietsov et al. (2024) Kuznietsov studied explainable AI in autonomous driving systems. The research highlighted transparency as a key factor for safety and trust. Interpretability improves driver confidence in AI decisions. The study supports integrating explainability frameworks. Trust-based safety systems depend on clarity.

20. Parasuraman & Colby (2015) Parasuraman introduced the Technology Readiness Index. The study explained how consumer optimism and innovativeness influence adoption of advanced technologies. In automotive AI, readiness determines acceptance speed. Safety assurance enhances readiness levels. Psychological preparedness influences technological evolution.

21. Enoch (2015) Enoch explored automated taxi and future mobility models. The research emphasized AI-driven safety benefits in shared mobility systems. It predicted accident reduction through automation. However, infrastructure challenges remain. Safety-driven automation shapes future transport models.

22. Gong et al. (2025) Gong surveyed perception techniques in safety-critical autonomous systems. The study detailed bird's-eye-view modeling and sensor integration. These advancements improve environmental awareness. AI perception accuracy enhances safety margins. Technological progress continues rapidly.

23. Ullrich et al. (2025) Ullrich examined AI safety assurance mechanisms. The research stressed risk management frameworks and system validation. It identified regulatory alignment as essential for safe implementation. AI safety standards are evolving globally. Governance supports technological growth.

24. Buckley et al. (2018) Buckley studied psychological determinants of automation acceptance. The research found that perceived safety strongly influences positive attitudes. Fear and uncertainty reduce adoption likelihood. Transparent communication improves trust. Psychological comfort supports AI integration.

25. Deloitte (2023) Deloitte's global automotive consumer study highlighted rising demand for AI-enabled safety systems. Consumers ranked safety as a top purchase factor. The report showed increased trust in automated features. It confirmed growing acceptance of intelligent mobility. Industry trends reflect technological confidence.

9. Findings

The review shows that AI safety research has steadily increased since 2015. Deep learning advancements led to major improvements in perception systems. Sensor fusion became the primary research area.

People will adopt AI technology when they trust its security and safety features. People must accept new technologies through psychological means which hold equal importance to their operational efficiency.

International research focuses heavily on validation frameworks. Regulatory standards play a crucial role in safe AI deployment.

India shows gradual but increasing integration of AI features. Cost and infrastructure remain major barriers.

Future research trends will focus on developing explainable AI systems and creating guidelines for ethical decision-making. Public trust will depend on institutional transparency throughout time.

10. Suggestions

1. Encourage affordable AI-based safety integration in Indian mid-range vehicles.
2. Promote academic research partnerships with automotive manufacturers.
3. Create AI training datasets that meet specific requirements for India.
4. AI validation will benefit from stronger regulatory framework development.
5. Public knowledge about AI safety advantages needs to be increased.

11. Conclusion

The evolution of AI in passenger vehicle safety has transformed global mobility systems between 2005 and 2025. AI technology has improved accident prevention through its development from basic driver assistance features to complex autonomous systems. International research shows that technological development occurs at a fast pace because strong regulatory systems support it.

The Indian market has adopted new technologies at a slow pace but shows signs of promising growth. As technological infrastructure improves and awareness increases, AI-based passenger vehicle safety systems are expected to become mainstream. Intelligent mobility needs AI systems that operate with high reliability and transparent design and ethical principles.

12. Limitations

The review considers only specific peer-reviewed articles published between 2005 and 2025. Certain industry reports which have newly emerged might have been excluded from this document. The study focuses only on passenger vehicles and excludes commercial transport.

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