

Autonomous Vehicles & Motor Vehicles Act 1988: Need for Legislative Reform

Swetha S¹, Nisvanthi M², Divya P³, Fastina S G⁴, Kavya P V⁵

^{1,2,3,4,5}*Department of Law, Sathyabama Institution of Science and Technology Chennai, Tamil Nadu, India*

Abstract—The concept of driverless vehicles, also known as autonomous vehicles, is gradually being implemented in India in the form of pilot projects and technological experiments in various cities across the country. Nevertheless, the Motor Vehicles Act, 1988, which regulates road transport and motor accident claims in India, is founded on the idea that every motor vehicle is driven by a human driver. As such, it presents significant legal challenges in the event of road accidents involving driver-less vehicles in the context of liability, insurance cover, and compensation to the victims. This research paper seeks to examine the adequacy of the provisions under the Motor Vehicles Act, 1988¹, as amended by the Motor Vehicles (Amendment) Act, 2019, in regulating driver-less vehicles integrated with Artificial Intelligence². The research methodology employed in this paper is doctrinal in nature, which entails the analysis of the provisions under the Motor Vehicles Act, 1988, as amended by the Motor Vehicles (Amendment) Act, 2019, as well as the principles established by the Indian courts in the context of motor accident claims. In addition, the paper seeks to highlight the inadequacy of the current legal framework in regulating driver-less vehicles integrated with Artificial Intelligence.

Index Terms—Autonomous Vehicles - Compensation - Accident - Liability - Motor Vehicles Act - Legislative Reform.

INTRODUCTION

Autonomous transportation systems³ are one of the biggest innovations in modern technology.

Autonomous transportation systems use artificial intelligence, sensors, machine learning, and automated control systems to transport goods and humans with little or no human intervention. Autonomous technology is being developed for various transportation systems such as cars, buses, trains, and other public transportation systems. The aim is to improve efficiency, reduce errors, and enhance road safety. Globally, various nations are investing in and testing autonomous transportation systems. These technologies have tremendous potential to revolutionize transportation by reducing accidents, improving traffic management, and ensuring safe transportation services. The development and use of autonomous transportation systems also raise several legal and regulatory challenges⁴. Transportation laws have generally been based on the principle that humans are responsible⁵ for controlling transportation systems. In autonomous transportation systems, humans are not in control; they are controlled by software developers or manufacturers. The issue of who is responsible in case of accidents is not clear.

In India, the existing legal regime relating to transportation, such as the Motor Vehicle Act and other such regulations, has been framed in the context of conventional vehicles and human drivers. It is possible that such a regime may not fully address the various issues relating to the law in the context of autonomous transportation systems. In the absence of such regulations, there may be issues relating to

¹ Motor Vehicles Act 1988 (India) as amended by the Motor Vehicles (Amendment) Act, 2019

² NITI Aayog, *National Strategy for Artificial Intelligence* (2018)

³ Society of Automotive Engineers, *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* (SAE J3016, 2021)

⁴ Matthew Scherer, “Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies and Strategies” (2016) *Harvard Journal of Law & Technology*.

⁵ Bryant Walker Smith, “Automated Vehicles Are Probably Legal in the United States” (2014) *Texas A&M Law Review* 411.

liability in the event of accidents and the safety of the general public.

In addition, the constitutional provisions relating to equality before the law under Article 14⁶ and the right to life and safety under Article 21⁷ are of significant importance in the context of the overall legal regime relating to the subject. It is the duty of the state to ensure that technological advancements in the field of transportation are not in any way harmful to the safety of the people.

It is in this context that the present research aims to identify the various issues relating to the legal and regulatory problems posed by the introduction of autonomous transportation systems in India.

REVIEW OF LITERATURE

The development of autonomous transport systems has gained much interest from researchers, policymakers, and legal experts worldwide. Various researchers have explored the developments in autonomous vehicles, along with the legal complexities associated with the implementation of these technologies. Various researchers have discussed the liability associated with accidents involving autonomous vehicles.

Bryant Walker Smith⁸, a legal expert, has emphasized the importance of traffic rules in the context of autonomous vehicles. He stated that traffic rules are essentially designed to accommodate human drivers, which may not be sufficient to address the complexities associated with autonomous vehicles. He based his argument on the legal provision that everything is permitted unless prohibited⁹. Furthermore, Ryan Calo¹⁰ has also explored the link between robotics, artificial intelligence, and law. He has based his research on the legal complexities associated with automated technologies, including the issues associated with accountability, product liability, and regulation.

Countries like the USA, Germany, and the UK have initiated the development of regulations regarding autonomous vehicles. These regulations emphasize safety aspects, responsibility of manufacturers, and government control over the safety of such technologies used in public transportation.

In India, academic literature on autonomous vehicles is limited. Some authors have studied the Motor Vehicles Act, 1988, and argued that it assumes the presence of a human driver who is responsible for driving the vehicle. The role of autonomous vehicle technology is to reduce or remove the role of humans in driving. There is ambiguity in such situations regarding who is responsible in case of an accident. The authors have argued that India needs to modify its transportation laws in response to emerging technologies.

Though existing literature provides significant information regarding autonomous vehicle technology and its legal issues, there is still a research gap in addressing issues regarding the regulation of autonomous transportation in India, especially in public transportation systems such as buses and trains. The research aims to contribute to the existing body of knowledge by studying the legal framework regarding autonomous transportation in India.

RESEARCH OBJECTIVES

1. To study the concept and development of autonomous transportation systems¹¹ such as cars, buses, trains, and other automated public vehicles.
2. To examine the existing legal framework governing transportation in India.¹²
3. To analyze the liability issues that arise from accidents and injuries involving autonomous transportation systems.
4. To evaluate the applicability of constitutional principles such as Article 14 and Article 21¹³ in regulating autonomous transport technologies.

⁶ Constitution of India, art 14.

⁷ Constitution of India, art 21.

⁸ Bryant Walker Smith, "Automated Vehicles Are Probably Legal in the United States" (2014) Texas A&M Law Review

⁹ ibid

¹⁰ Ryan Calo, "Robotics and the Lessons of Cyberlaw" (2015) California Law Review

¹¹ Society of Automotive Engineers, *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* (SAE J3016, 2021)

¹² Motor Vehicles Act, 1988 (India) as amended by the Motor Vehicles (Amendment) Act, 2019

¹³ Constitution of India, arts 14 and 21

5. To identify the legal gaps in the current Indian laws relating to autonomous vehicles and other automated transport systems.
6. To suggest possible legal reforms and policy measures for implementing and regulating autonomous transportation in India.

METHODOLOGY:

The research methodology that has been adopted in this research is a doctrinal research methodology. This methodology of research is based on studying and analyzing existing legal principles, statutes, and academic writings related to autonomous transportation systems. This methodology of research is based on examining the legal framework of transportation in India and identifying the challenges that are faced by introducing autonomous vehicles such as cars, buses, trains, etc.

The research is based on secondary sources of data, such as books, research articles, legal journals, government reports, and online legal databases. The research will examine statutory provisions of the Motor Vehicles Act, 2019,¹⁴ which is an amended version of the Motor Vehicles Act, 1988. Similarly, it will examine railway regulations and constitutional provisions to understand how the current legal framework regulates transportation in India and how it deals with issues related to autonomous transportation systems.

Moreover, it will examine judicial decisions and legal commentaries¹⁵ on transportation laws and liability. By examining these issues, this research aims to identify the gaps in the current Indian legal framework related to autonomous transportation systems and how it can deal with issues related to autonomous transportation systems in India.

I. CONCEPT AND EVOLUTION OF AUTONOMOUS TRANSPORTATION

Autonomous transportation is defined¹⁶ as transport systems that can operate independently with little or

no human intervention through the use of advanced technologies such as artificial intelligence, sensors, cameras, radar systems, and automated driving mechanisms¹⁷. Autonomous transportation is commonly associated with self-driving cars. The concept is also extended to include self-driving buses, trains, and other transport systems. The main objective behind autonomous transportation is to improve transport efficiency, reduce errors, and enhance safety on roads and rails.

The concept of automated transportation has taken several decades to develop. The earliest innovations in automated transportation were centered on vehicle automation. The earliest innovations in vehicle automation were cruise control systems and automatic braking systems. The development of artificial intelligence and machine learning has prompted several researchers and companies to develop transport systems that can operate independently without any human intervention. In recent times, several automobile companies and technology companies have invested greatly in autonomous vehicle research. Automated train systems and intelligent public transport systems have also been implemented in several parts of the world. These innovations depict a gradual move towards intelligent transport systems.

1.1 Levels of Vehicles Automation

Autonomous vehicles are also classified at different levels based on the level of automation. The levels range from minimal to complete automation. The lowest level of automation enables the vehicle to assist the driver in performing certain functions, like steering or braking. The higher levels enable the vehicle to perform all driving functions independently, without any human intervention. The fully autonomous vehicle represents the highest level of automation, where the vehicle can perform all driving functions safely without any human intervention.

1.2 Technological Components of Autonomous Systems

Systems for On-Road Motor Vehicles (SAE J3016, 2021)

¹⁷ National Highway Traffic Safety Administration (NHTSA), *Automated Driving Systems: A Vision for Safety 2.0* (2017).

¹⁴ Motor Vehicles (Amendment) Act, 2019 (India)

¹⁵ Avtar Singh, *Introduction to the Law of Torts and Consumer Protection* (LexisNexis, latest edn).

¹⁶ Society of Automotive Engineers, *Taxonomy and Definitions for Terms Related to Driving Automation*

Autonomous transport systems employ a variety of technologies to ensure effective functioning. First, artificial intelligence plays a critical role in enabling the vehicle to make decisions in real time. Sensors and cameras also assist the vehicle in detecting obstacles, conditions of the road, and traffic signals. On the other hand, radar and LiDAR ¹⁸ technologies assist in determining the distance between objects and the objects themselves. Finally, sophisticated software plays a critical role in integrating all these technologies to ensure effective movement of the vehicle.

1.3 Importance and Challenges of Autonomous Transportation System

There are several potential benefits of autonomous transportation. For instance, it may minimize traffic accidents¹⁹ resulting from human errors, improve fuel efficiency, and enhance traffic management. Autonomous transport systems may also be beneficial to elderly and disabled people who may find it hard to drive vehicles.

Despite the potential benefits of autonomous transportation, there are a number of challenges associated with its adoption. Some of these challenges include technological, security, financial, and legal challenges. These challenges are crucial in ensuring that autonomous transportation systems are used in a manner that is beneficial and safe. Technology is likely to play a crucial role in the future of transportation. For instance, in the near future, autonomous vehicles may be used to develop more efficient and safer transport systems. As a result, there is a significant need to ensure that autonomous vehicles are integrated into existing transport infrastructure. At the same time, it is crucial to develop appropriate legal frameworks ²⁰ that ensure that autonomous transportation systems are used in a manner that is beneficial to society.

¹⁸ Charlie Miller and Chris Valasek, "Remote Exploitation of an Unaltered Passenger Vehicle" (2015) (discussing vehicle systems and sensor vulnerabilities).

¹⁹ Noah J. Goodall, "Machine Ethics and Automated Vehicles" (2014) *Transportation Research Record*.

II. LEGAL FRAMEWORKS GOVERNING TRANSPORTATION IN INDIA

Transportation is an essential factor in the development of any country. In India, transportation is governed by²¹ various acts and policies. These acts and policies aim at ensuring road safety, controlling transportation, and protecting the rights of passengers²² and the general public. The acts include vehicle registration, licensing drivers, insurance, traffic, and accident liability.

Most of these acts were formulated based on conventional vehicles and drivers. The recent development in transportation, such as self-driving cars, self-driving buses, and trains, has posed new challenges in the existing legal framework. The new challenges need to be analyzed from a legal perspective.

2.1 The Motor Vehicles (Amendment) Act, 2019

The Motor Vehicles Act, 1988 is the governing legislation for road transportation in India. It regulates the registration of motor vehicles, the grant of driving licenses, control of traffic, insurance of motor vehicles, and compensation to victims of road accidents. It also includes provisions for imposing penalties for violating traffic regulations and specifies authorities that regulate transportation legislation.

The Motor Vehicles (Amendment) Act, 2019 has been enacted to enhance road safety regulations and improve the efficacy of transportation systems in India. This legislation has introduced stringent penalties for violating traffic regulations, enhanced provisions for compensating victims of accidents, and increased responsibility on drivers and owners of motor vehicles. One of the notable aspects of this legislation is that it takes into consideration that a human driver is in control of the vehicle. In the context of autonomous vehicles, this is a problem because the control of such a vehicle could also be vested in automated systems, software programs, and artificial intelligence.

²⁰ Matthew Scherer, "Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies, and Strategies" (2016) *Harvard Journal of Law & Technology*.

²¹ Motor Vehicles Act, 1988 (India)

²² Ministry of Road Transport and Highways (MoRTH), Road Safety Policy (Government of India)

Therefore, in the context of accidents involving such vehicle's, determining responsibility is legally complex.²³

While the amendment has improved some aspects of road safety and transport regulation, the issue of autonomous vehicles and automated transportation systems is not mentioned in the amendment. It is assumed in the Act that the driver of the vehicle is a human being, and there is no mention of the issue of automated vehicles and transportation systems.

2.2 Railway Regulations & Automated Train Systems

The Indian railway transportation system²⁴ is subject to various laws and regulations concerning the administration of railway services, the safety of passengers, and the administration of railway infrastructure. Technological advancements have seen the adoption of automated train systems in various countries, where trains are driven using computer systems as opposed to human train drivers.

If the use of similar train systems is introduced in India, various legal issues concerning the safety of operations, supervision, and liability in the event of accidents involving automated railway systems²⁵ will have to be considered.

2.3 Government Regulation for Public Transportation System

The services provided by public transportation modes such as buses, metro, etc., are regulated by both national regulations and state transport regulations. The regulations ensure the safe, efficient, and interest-based operation of public transportation modes.

The government plays a significant role in the regulation of transportation services through legislation, policy formulation, etc. The regulatory bodies are responsible

for ensuring the transportation services meet the required standards in terms of safety and legislation.

The regulatory bodies might need to formulate policies regarding the testing and safe operation of autonomous

buses, which have been introduced in public transportation modes. The regulations might need to be amended in this context. The government has to formulate the required regulations in the context of autonomous transportation, which ensures the safe operation of the transportation services²⁶.

III. LIABILITY IN AUTONOMOUS TRANSPORTATION ACCIDENTS

Liability is defined²⁷ as the responsibility for damage or harm caused to another individual. In traditional transportation systems, liability is attributed to a human being who operates the vehicle. However, in autonomous transportation systems, vehicles are operated using artificial intelligence. This brings about uncertainty regarding liability in case of an accident.

3.1 Operator / Driver Liability

In normal vehicles, the responsibility of driving safely and adhering to traffic rules rests with the driver. However, in autonomous vehicles, the role of the driver might be restricted or might not exist at all. If the driver exists in the autonomous vehicle but fails to act appropriately in critical situations, liability might arise.

3.2 Manufacturer Liability

The responsibility lies with the manufacturers to ensure the design and production of a safe vehicle. In the event of an accident happening because of the defect in the design, hardware, or safety features of the vehicle, the manufacturers could be held liable²⁸ under the doctrine of product liability.²⁹

3.3 Software Developer Liability

The vehicle is also dependent on complex software and artificial intelligence³⁰ to make appropriate driving decisions. In case of accidents resulting from software failure or system failure, the software

²³ Ryan Calo, "Robotics and the Lessons of Cyberlaw" (2015) *California Law Review*

²⁴ Ministry of Railways, Railways Act, 1989 (India)

²⁵ International Union of Railways (UIC), *Automation in Railways: International Practices and Trends*.

²⁶ NITI Aayog, *National Strategy for Artificial Intelligence* (2018).

²⁷ Avtar Singh, *Introduction to the Law of Torts and Consumer Protection* (LexisNexis, latest edn).

²⁸ *Donoghue v Stevenson* [1932] AC 562 (HL)

²⁹ Product Liability—manufacturer's liability for defective products causing harm.

³⁰ NITI Aayog, *National Strategy for Artificial Intelligence* (2018).

developer/technology supplier could also be held legally responsible.

3.4 Product Liability

Product liability³¹ refers to a situation where a product that has a defect causes harm to the user or the public at large. In the case of autonomous transport vehicles, a defect in the technology used could result in accidents, thereby making the manufacturer or producer liable.

3.5 Liability in Public Autonomous Transportation

Another aspect is the use of autonomous buses, trains³², etc., which comes under the responsibility of the transport authorities or companies. In the event of any accident happening because of the failure of the system or poor maintenance, the company is also liable.

3.6 Challenges in Determining Liability

There are various challenges associated with the determination of liability in accidents involving autonomous transportation systems. These include the involvement of multiple parties in the accident and the complexity of the artificial intelligence system. Additionally, there is no specific legal provision that can be applied in such cases.

Another challenge associated with accidents involving autonomous transportation systems is the lack of clear legal standards³³ in the safety and testing of such vehicles. This may pose a challenge in the application of the law in such cases.

IV. CONSTITUTIONAL PERSPECTIVE ON AUTONOMOUS TRANSPORTATION

The development of autonomous transportation systems also raises some important constitutional issues, including the issue of public safety, equality

before the law, and the role of the state in governing the new technology. The Constitution of India has granted some fundamental rights³⁴ that guide the development of technology in society.

4.1 State Responsibility in Regulating Technology

In this case, the government has an essential role in regulating the new technologies that may have an impact on the safety of the people. In the case of the autonomous transportation systems, the government has the role of ensuring that the necessary legal frameworks and guidelines are established. This is based on the constitutional role of the state³⁵ in the protection of the basic rights of the people³⁶. Innovation in technology is essential in the development of the economy and the people. However, the constitutional provisions should be taken into account in the formulation of the regulations concerning the autonomous transportation systems. In this case, the regulations should focus on the development of the people and the protection of the basic rights such as equality, safety, and access to justice.

4.2 Article 14: Equality Before Law

The Constitution guarantees in Article 14³⁷ that all individuals have the right to equality before the law and the right to equal protection under the law. In the context of autonomous transportation, this means that the law on liability, safety, and compensation should be equally applied to all individuals affected by the operation of autonomous vehicles. The victims of the accident involving the autonomous vehicles have the right to equal justice.³⁸

4.3 Article 21: Right to Life and Personal Safety

Article 21³⁹ provides for the right to life and liberty. The Supreme Court has held that this includes the right to life in safety and dignity⁴⁰. In respect to

³¹ Product Liability—liability for defective products causing harm.

³² Ministry of Housing and Urban Affairs, *Urban Transport Policies and Public Transport Regulation in India*

³³ International Transport Forum, *Automated and Autonomous Driving: Regulation under Uncertainty* (2015).

³⁴ Constitution of India, Part III (Fundamental Rights)

³⁵ Doctrine of State Responsibility—duty of the state to protect citizens' rights.

³⁶ Supreme Court of India, interpretation of fundamental rights in evolving technological contexts.

³⁷ Constitution of India, art 14.

³⁸ Constitution of India, art 14.

³⁹ Constitution of India, art 21.

⁴⁰ *Maneka Gandhi v Union of India* (1978) 1 SCC 248.

transportation, this means that the state is responsible for ensuring that roads, transport, and vehicles operate in such a way that they promote safety for all. In this respect, it is evident that the adoption of autonomous transport has to be done in such a way that it ensures safety for all lives.

4.4 Need for Constitutional Balance

While innovation in technology is crucial for economic and social development, it is necessary to strike a balance with constitutionalism⁴¹. Rules regarding autonomous transportation must be able to strike a balance between innovation in technology and constitutional rights such as equality, safety, and justice.

V. CYBERSECURITY RISKS IN AUTONOMOUS SYSTEMS

The rapid development of autonomous transport systems such as cars, buses, and trains is changing the way people view modern transport systems. These autonomous transport systems make heavy use of various advanced technologies such as artificial intelligence and machine learning to function effectively without the need for human intervention. Although these technological developments are beneficial in terms of safety and efficiency, they also pose complex and challenging issues

5.1 Risk of Hacking Autonomous Vehicles

Autonomous vehicles make use of complex technologies such as software, sensors, artificial intelligence, and communication systems such as GPS and cloud-based communication. This high dependency on digital technologies makes them vulnerable to various forms of hacking⁴². Hackers can easily penetrate the vehicle's operating system, communication systems, or devices to gain unauthorized access to the vehicle.

Such unauthorized accesses⁴³ can enable the hacker to control the vehicle's functions such as steering,

braking, acceleration, and even navigation. Remote vehicle hacking is a serious concern as it can be carried out without physical access to the vehicle. With the increased interconnectedness of autonomous vehicles through technologies such as Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication⁴⁴, cybersecurity is a major concern in the development of autonomous vehicles., especially in terms of cybersecurity.

5.2 Threats to Public Safety

There are also threats to public safety arising from cybersecurity attacks on autonomous systems. This is because if a vehicle's control system is attacked, it may start behaving erratically, resulting in accidents and even deaths. Unlike traditional vehicles whose drivers are able to respond to unforeseen events, autonomous vehicles are only able to respond to events based on their programming and may therefore be compromised if such a programming is attacked.

The problem is also compounded when considering public transport such as buses and trains that are controlled autonomously; a single attack could compromise the safety of many lives at once. Furthermore, a coordinated attack on many vehicles or transport systems could compromise the entire traffic network, causing widespread chaos and resulting in significant losses for the economy.

5.3 Need for Secure Software Systems

In order to address these risks, it is imperative that highly secure software systems for autonomous transportation be developed and implemented. Such software must include security features at every stage of system design, ranging from the hardware, software, and communication network. Features like encryption, firewalls, and intrusion detection, along with regular security upgrades, must be implemented in order to avoid any unauthorized use of the system.

Furthermore, there must be regular monitoring, along with the implementation of real-time detection systems, in order to identify any cyber-attacks and take

⁴¹ Constitutionalism—balancing state power with fundamental rights.

⁴² European Union Agency for Cybersecurity, *Cybersecurity and Resilience of Smart Cars* (2016).

⁴³ Charlie Miller and Chris Valasek, "Remote Exploitation of an Unaltered Passenger Vehicle" (2015).

⁴⁴ National Highway Traffic Safety Administration (NHTSA), *Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application*.

immediate action. The manufacturers must follow the ‘security by design’⁴⁵ approach, which means that the system must include safety features right from the start, rather than adding them later.

From the legal point of view, the government must implement stringent cybersecurity standards and laws in order to ensure compliance by the manufacturers. In the case of India, there is a need for the government to strengthen cybersecurity laws⁴⁶ in the context of the evolution of technology like autonomous transportation. Such cybersecurity will not only protect the individual, but the government will also gain the trust of the public, which will help in the acceptance of autonomous transportation in the future.

VI. NEED FOR LEGAL REFORMS

The rapid development in the field of autonomous transportation systems has given rise to various legal challenges, which the current transportation laws in India are not able to address. The current transportation laws in India were framed for conventional vehicles driven by human beings, which makes it difficult to apply the current transportation laws in the context of autonomous transportation systems.

The current transportation laws in India, including the Motor Vehicle Act⁴⁷, are based on the assumption that the vehicle is driven by a human being. In the context of autonomous transportation systems, the decisions are being made by artificial intelligence and automated software, which makes it difficult to fix the liability in the event of an accident.

6.1 Need for Specific Legislation

With the development of technology in the field of autonomous vehicles, buses, trains, and others, it has become essential to enact legislation that specifically regulates the testing, operation, and safety⁴⁸ of such vehicles. Such regulations would also include the role

and responsibilities of the manufacturers, operators, software developers, and the owners of the vehicles.

Proper safety standards and guidelines are essential for the safe operation of autonomous transportation vehicles. It is essential for the government authorities to develop guidelines for the testing and monitoring of the vehicles before they are allowed to operate on the roads.

The government has to take a proactive role in the development of regulations that would control the operation of autonomous vehicles while promoting the development of technology in the field.

Case Study

1. Uber Self-Driving Car Accident (2018, USA)⁴⁹

Background of the Case:

Uber had been testing its self-driving car technology in Arizona as part of its autonomous vehicle testing program.

Facts of the Case:

The Uber autonomous car⁵⁰ ran over a pedestrian who had crossed the road in 2018. The car had detected the pedestrian through its sensors, but the sensors had not been able to categorize the object in time. The human safety driver had also not reacted in time to the accident.

Legal Issues:

1. Was the human safety driver negligent?
2. Was Uber negligent?
3. Was the software system defective?

Outcome of the Case:

The safety driver had been charged for negligence, while Uber had entered into a settlement with the family of the deceased.

Relevance to India:

⁴⁵ Security by Design—integration of security measures at the initial design stage of systems.

⁴⁶ Ministry of Electronics and Information Technology, *Information Technology Act, 2000* (India).

⁴⁷ Motor Vehicles Act, 1988 (India).

⁴⁸ National Highway Traffic Safety Administration (NHTSA), *Automated Driving Systems: A Vision for Safety 2.0* (2017).

⁴⁹ National Transportation Safety Board (NTSB), *Collision Between Vehicle Controlled by Developmental Automated Driving System and Pedestrian*, Tempe, Arizona (2018).

⁵⁰ Uber Technologies Inc. settlement reports (2018).

The case is relevant to India as it is difficult to place the blame for the accident and the need for the formulation of laws in the country.

2. Tesla Autopilot Accident Cases (USA)

Background of the Case:

Tesla has come up with a feature called “Autopilot⁵¹” that helps drivers steer, brake, and accelerate their vehicles. It is important to note that it does not work independently; it needs to be supervised by the driver.

Facts of the Case:

There have been many reported cases of Tesla cars running on Autopilot mode crashing and resulting in fatal accidents⁵². In one such case, the vehicle did not sense a truck coming in front of it and crashed into it, resulting in the death of the driver.

Legal Issues:

1. Was the Autopilot feature of Tesla defective?
2. Was the driver misusing the feature?

Outcome of the Case:

In this case, it was found that both the driver and the Autopilot feature were responsible for the accident. It was also argued that the driver needs to be attentive while driving the vehicle on Autopilot mode.

Relevance of the Case to India:

This case also brings to light the concept of shared liabilities and how even semi-autonomous vehicles are creating confusion among people, which has yet to be dealt with in India.

3. Automated Train Systems (Driverless Metro Systems)

Background of the Case:

Several countries have introduced driverless metro trains running on automated train systems. These train systems are controlled centrally and use sophisticated signaling systems.

Facts of the Case:

There have been cases where these automated train systems have suffered technical difficulties or have stopped running suddenly. These have caused safety concerns⁵³ and resulted in small-scale accidents. Although these have not resulted in fatalities, they have brought to light several legal implications of such cases.

Legal Issues:

1. Liability of transport authorities
2. Liability of developers and maintenance teams⁵⁴ of the automated train systems
3. Safety standards and accountability for failure of the train systems

Outcome of the Case:

In most cases, the transport authorities have accepted their liabilities and have implemented stricter safety standards to ensure that such failures are avoided in the future.

Relevance of the Case to India:

India is developing new metro rail and rail networks; therefore, when such automated train systems are introduced in the future, legal implications of such train systems need to be addressed.

4. Navya Autonomous Shuttle Accident (2017, USA)

Background of the Case:

The French company, Navya⁵⁵, developed an autonomous shuttle for public use in Las Vegas, USA⁵⁶. The autonomous shuttle was designed to operate without the presence of a driver.

Facts of the Case:

On its first day of operation, the autonomous shuttle was involved in a minor accident with a truck. The autonomous shuttle detected the presence of the truck

⁵¹ Tesla Inc., *Autopilot System Overview and Safety Reports*.

⁵² National Highway Traffic Safety Administration (NHTSA), *Tesla Crash Investigations Reports*

⁵³ World Health Organization, *Global Status Report on Road Safety* (2018).

⁵⁴ Matthew Scherer, “Regulating Artificial Intelligence Systems: Risks, Challenges,

Competencies, and Strategies” (2016) *Harvard Journal of Law & Technology*.

⁵⁵ Navya, *Autonomous Shuttle Deployment Reports* (2017).

⁵⁶ City of Las Vegas, *Autonomous Shuttle Pilot Program Reports* (2017).

but was not able to avoid the accident. There were no reported injuries during the accident.

Legal Issues:

1. Whether the autonomous shuttle responded appropriately or not
2. The responsibility of the shuttle operator
3. The role of the human error on the part of the driver of the truck

Outcome of the Case:

The accident was attributed to the driver of the truck, but the accident also raises the issue of the limitations of autonomous vehicles.

Relevance to India:

This case shows that even low-speed autonomous public transport systems are not risk-free and require proper legal and safety regulations.

5. Google Self-Driving Car Minor Collision (2016, USA)

Background of the Case:

Google ⁵⁷ was conducting experiments with its self-driving cars in California as part of its project of developing an autonomous driving system.⁵⁸

Facts of the Case:

A Google self-driving car collided with a public bus due to incorrect judgment of the speed of the bus while trying to merge with the traffic flow.

Legal Issues:

1. Whether the Google self-driving car made an incorrect decision in judgment
2. Whether the technology developer was liable
3. Whether machines have the capacity to judge what is right and what is wrong in decision-making

Outcome of the Case:

Google accepted partial blame for the accident and said that the software had misjudged the behavior of the driver of the public bus.

Relevance of the Case to India:

The relevance of the case to India is that it shows that machines have the capacity to make incorrect decision-making choices.

VII. RECOMMENDATIONS

Because more and more people are using self-driving cars and the legal problems that come with them, it is important to take a broad and forward-thinking approach to making rules and policies. The following suggestions are meant to fill in the gaps in the current legal system and make sure that self-driving cars, buses, and trains can safely and effectively be added to the Indian transportation system.

1. Introduction of Specific Autonomous Transportation Laws:

India doesn't have a specific set of laws that deal with self-driving cars right now. Current laws are mostly made for cars that people drive, so they don't work well for autonomous systems⁵⁹. Because of this, we need to pass laws that clearly define what autonomous vehicles are, put them into groups based on how automated they are, and set rules for how they can be tested, approved, and used.

2. Creating a Liable Framework:

Liability is among the most significant obstacles for autonomous transportation; hence, it is incumbent upon society to create a defined framework that identifies the responsible parties in the event of an accident involving an autonomous vehicle. There will be multiple potential responsible parties including but not limited to: the owner of the vehicle; the manufacturer of the vehicle; the software developer of the vehicle; and, the operator of the vehicle. Per these guidelines, the courts will then issue legally binding rulings as to how liability will be apportioned if the subject case involves a failure of the autonomous vehicle system; a human failure; or, an external environmental factor. The creation of such liability guidelines allows for the reduction in the number of

⁵⁷ Waymo LLC, *Self-Driving Car Project Reports* (2016).

⁵⁸ Waymo LLC, *Monthly Self-Driving Car Report* (California DMV, 2016).

⁵⁹ NITI Aayog, *National Strategy for Artificial Intelligence* (2018)

legal precedents created and guarantees that a victim will receive full restitution.”

3. *Safety and Testing Standards:*

Autonomous vehicles must have strong safety and testing controls before being allowed on our public roadways. A regulatory agency should require extensive testing of all autonomous systems in a variety of different traffic and environment settings. A certification system⁶⁰ should be established that guarantees that any vehicle that is certified has passed some minimum level of acceptable safety measures. There should also be continuous monitoring⁶¹ and periodic inspections to ensure that the system remains safe throughout its useful life.

4. *Increasing Cyber Security Measures*

Due to the large possibility of an effective cyber-attack against autonomous systems; it is imperative that there is a strong cyber security framework⁶² in place for these systems. As part of the manufacturing of autonomous systems, manufacturers should be required to have secure software design methods, including but not limited to encryption of data, using intrusion detection systems, and routinely updating software to protect against those types of attacks. Additionally, standards and guidelines will need to be established by government agencies for the protection of vehicles from cyber-attacks and system manipulation. The assurance of cyber security will help to build public confidence and avoid large-scale risks from a breach of the system.

5. *Data Protection and Privacy Regulations:*

The Automatic Vehicle comprises many pieces of data, such as people and places, that are gathered and stored; these types of data require measures of protection^{63,64} against misuse or access by unauthorized personnel. Legal provisions need to be implemented sufficient to regulate data collection, storage, and transfer

regarding the autonomous system. Users should know what information about them has been collected and that the penalties for violating the data privacy are strictly enforced.

6. *Development of Insurance and Compensation Mechanisms*

Traditional insurance frameworks do not seem to adequately provide coverage for incidents caused by autonomous systems because of their definition of liability in terms of the "at fault" party. There must be new models in place to address both system failure and to provide a multi-entity or "shared liability." Coverage must also precisely define who the insured entities are so that each party will receive adequate compensation in a reasonable timeframe. Technology may require expanding the participation of insurers in the industry.

7. *The Importance of Infrastructure Development and Public Education:*

In order to effectively implement autonomous transport, there must be adequate infrastructure such as smart roads, traffic management systems and communication networks for these technologies to thrive. Also, it is important to develop education campaigns that will educate the public on the operation of autonomous transportation systems as well as their potential benefits and risks in order foster public confidence so that they are willing to accept and adopt the new technology.

8. *Promoting Research and Innovation:*

The government should support research and development of autonomous⁶⁵ transportation systems by offering funding, incentives, and opportunities for academia and industry to collaborate. Supporting the development of innovative technologies will enable India to keep up with technological advances

⁶⁰ International Organization for Standardization, *Safety and Certification Standards for Autonomous Systems*.

⁶¹ Ministry of Road Transport and Highways (MoRTH), *Vehicle Safety and Monitoring Policies*.

⁶² International Organization for Standardization, *ISO/SAE 21434: Road Vehicles – Cybersecurity Engineering* (2021).

⁶³ Ministry of Electronics and Information Technology, *Information Technology Act, 2000* (India).

⁶⁵ International Transport Forum, *Automated and Autonomous Driving: Regulation under Uncertainty* (2015).

occurring around the world while also ensuring that any legal or ethical issues are appropriately addressed.

VIII. CONCLUSION

Autonomous systems are changing the way we think about transportation. Autonomous vehicles like cars, buses and trains are becoming a reality. They promise to make transportation more efficient reduce mistakes made by humans and make it easier for people to get around. However, there are also some problems that come with these benefits.

One of the issues is who is responsible when something goes wrong. Autonomous vehicles use intelligence to make decisions, which makes it hard to figure out who is at fault. Is it the manufacturer, the software developer, the owner or the user? This is a question that needs to be answered. We need to come up with a way of thinking about responsibility that takes into account the role of technology.

Another big concern is cybersecurity. Autonomous systems rely on computers and networks to work which makes them vulnerable to hacking and kinds of attacks. This is not a problem for individual safety but also for public infrastructure and national security. We need to make sure that autonomous systems are secure and that we are constantly monitoring them for problems.

Autonomous systems also collect a lot of data about people, which raises questions about privacy. Who owns this data. How is it being used? We need to make sure that we have rules about how data is collected, stored and used. We do not want technological progress to come at the cost of our rights.

The way we ensure vehicles is also a problem. Current insurance models are designed for human-driven vehicles. Do not take into account the complexities of autonomous decision-making. We need to come up with insurance frameworks that can handle shared responsibility and provide fair compensation to victims.

Autonomous vehicles and systems have the potential to greatly improve our lives. We need to make sure that we have the right rules and regulations in place. This requires an effort from lawmakers, technologists, insurers and society as a whole. We need to balance innovation with regulation to create a sustainable ecosystem for autonomous systems.

For example, in countries like India, the legal framework for systems is still in its early stages. Policymakers need to take a looking approach and create regulations that can keep up with technological developments. We need to make sure that we are prepared for the challenges that come with systems.

In conclusion autonomous vehicles and systems are the future of transportation. Autonomous vehicles and systems hold a lot of promise. We need to make sure that we are prepared for the challenges that come with them. We need to develop legal, regulatory and ethical frameworks that can handle the complexities of autonomous technology. This will require a lot of work and collaboration but it will be worth it, in the end. Autonomous vehicles and systems have the potential to greatly improve our lives. We need to make sure that we realize their benefits while minimizing their risks.

IX. FINDINGS

The study reveals that the existing transportation laws in India, including the Motor Vehicles Act, were primarily framed for vehicles that operate with the intervention of human drivers. However, the existing laws are not sufficient to address the legal concerns related to the operation of autonomous transportation technologies, including self-driving cars, buses, and trains. It may be inferred that the existing laws may not be sufficient to effectively regulate the newly emerging technologies in the field of transportation.

The second major conclusion that may be derived from the study is the difficulty in attributing liability in the event of accidents related to the operation of autonomous transportation technologies. Since the operation of autonomous vehicles involves the participation of different stakeholders, including the manufacturers, software developers, owners, and operators of the vehicles, it may be extremely difficult to attribute liability in the event of accidents.

The study reveals the need for a new legal framework that may effectively address the legal concerns related to the operation of autonomous transportation technologies.

REFERENCES

- [1] B. W. Smith, "Automated Vehicles Are Probably Legal in the United States," *Texas A&M Law Review*, 2014.

- [2] B. W. Smith, "Automated Driving and Product Liability," *Michigan State Law Review*, 2017.
- [3] R. Calo, "Is the Law Ready for Driverless Cars?" *Communications of the ACM*, 2018.
- [4] J. Villasenor, "Products Liability and Driverless Cars: Issues and Guiding Principles for Legislation," *Brookings Institution*, 2014.
- [5] M. L. Kubica, "Autonomous Vehicles and Liability Law," *The American Journal of Comparative Law*, 2022.
- [6] M. MacCarthy, "Setting the Standard of Liability for Self-Driving Cars," *Brookings Institution*, 2025.
- [7] M. Alawadhi *et al.*, "Review and Analysis of the Importance of Autonomous Vehicle Liability," *International Journal of System Assurance Engineering and Management*, 2020.
- [8] *The Constitution of India*, 1950.
- [9] *The Motor Vehicles Act*, No. 59 of 1988, India, 1988.
- [10] *The Motor Vehicles (Amendment) Act*, No. 32 of 2019, India, 2019.