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ABSTRACT

Artificial Intelligence has been a challenge for computing since its inception, learning, problem-solving, and language processing have been the areas of focus. Some of the successful applications of AI have been in the areas of expert systems, natural language understanding, speech recognition, and machine vision. The objective of this paper is to explore the role of AI in transportation engineering. The paper discusses the various applications of AI in transportation engineering, including traffic management, transportation planning, and safety management. The paper also discusses the challenges and limitations of AI in transportation engineering and provides insights into the future of AI in this field. The paper concludes that AI has the potential to revolutionize transportation engineering by improving efficiency, safety, and sustainability. However, the successful implementation of AI in transportation engineering requires a multidisciplinary approach that involves collaboration between engineers, computer scientists, and policymakers. The paper also highlights the need for further research in this area to address the challenges and limitations of AI in transportation engineering.

1. Introduction

Technology has been a driving force in the development of transportation engineering. From the invention of the wheel to the development of modern transportation systems, technology has played a significant role in improving the efficiency, safety, and sustainability of transportation systems. In recent years, the rapid advancement of technology has led to the development of new and innovative transportation systems that have the potential to revolutionize the way we travel. However, the successful implementation of these systems requires a multidisciplinary approach that involves collaboration between engineers, computer scientists, and policymakers.

Transportation engineering is a complex field that involves the planning, design, construction, operation, and maintenance of transportation systems. It is a field that is constantly evolving, and engineers are always looking for new and innovative ways to improve the efficiency, safety, and sustainability of transportation systems. One of the most promising areas of research in transportation engineering is the application of artificial intelligence (AI) and machine learning (ML) techniques. These techniques have the potential to revolutionize the way we design, operate, and maintain transportation systems.

1.1. Artificial intelligence

Artificial intelligence (AI) is a branch of computer science that aims to create machines that can perform tasks that would normally require human intelligence. AI has been a subject of interest for many years, and it has been applied in various fields, including transportation engineering. The goal of AI is to create machines that can learn, reason, and make decisions like humans. AI has been used in transportation engineering to improve the efficiency, safety, and sustainability of transportation systems. AI has been used in various applications, including traffic management, transportation planning, and safety management.

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Table 1
AI functionalities and use cases.

AI Function	Use-cases
Non-linear prediction	Traffic flow modeling
Control functionalities	Signal control, dynamic route guidance
Pattern recognition	Automatic incident detection, facial recognition, collective intelligence
Clustering	Identification of spatial correlations, driver behavior
Planning	Vehicle routing, public transport planning
Optimization	Design of optimal networks, vehicle routing, workplace management, optimal signal programming

Adaptive control (Sadek, Artificial Intelligence Techniques in Transportation Systems, 2007) [7].

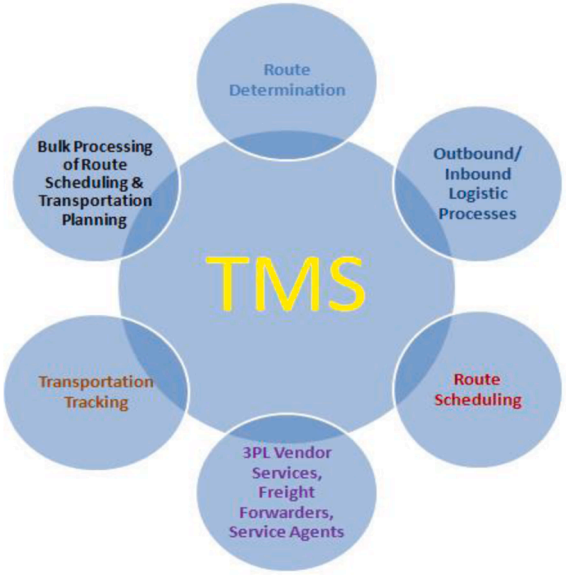

Fig. Functions of TMS.
(Source: Vasconcellos, 2013)

deaths, property damage, and delay. Annual costs in the US alone are estimated at $230 billion [20]. Governments around the world are investing billions of dollars in order to counteract these negative externalities. Advanced traffic management systems, advanced traveler information systems, and public transportation systems are available to reduce congestion, improve safety, and reduce emissions [21]. Intelligent transportation systems (ITS) are the application of information and communication technologies to transportation, including the collection, analysis, and dissemination of information to drivers, travelers, and managers [22]. ITS is a rapidly growing area of transportation engineering, and is expected to grow substantially in the coming years. India is an interesting case study because of its strong economic growth and rapid motorization. Many of the developing countries in Asia, Africa, and Latin America are following a similar trajectory. Therefore, the lessons learned in India will be relevant to many other countries around the world.

1.2. Land transport

Most of the early research in the area of transportation science was focused on land transportation, and this is still the largest area of research in transportation engineering. Land transportation can be divided into three categories: road transportation, rail transportation, and pedestrian transportation. Road transportation is the most widely used mode of transportation in the world, and it is also the most flexible. It can be used for both passenger and freight transportation, and it can be used in both urban and rural areas. Rail transportation is the most efficient mode of transportation for long distances, and it is also the most environmentally friendly. It can be used for both passenger and freight transportation, and it can be used in both urban and rural areas. Pedestrian transportation is the most basic mode of transportation, and it is also the most flexible. It can be used for both passenger and freight transportation, and it can be used in both urban and rural areas.

Land transportation is a complex system that is affected by many factors, including the physical infrastructure, the vehicles, the drivers, the weather, and the traffic. The physical infrastructure includes the roads, railways, and pedestrian walkways. The vehicles include cars, trucks, buses, and trains. The drivers include the people who operate the vehicles. The weather includes the rain, snow, and fog that can affect the safety and efficiency of transportation. The traffic includes the number of vehicles and pedestrians that are using the transportation system at any given time.

Land transportation is a critical component of the economy, and it is also a major source of pollution and congestion. The goal of land transportation engineering is to design, operate, and maintain transportation systems that are safe, efficient, and environmentally friendly. This is a challenging task, because the transportation system is affected by many factors, and it is constantly changing. The use of intelligent transportation systems (ITS) is one way to address these challenges. ITS is the application of information and communication technologies to transportation, including the collection, analysis, and dissemination of information to drivers, travelers, and managers [22]. ITS is a rapidly growing area of transportation engineering, and is expected to grow substantially in the coming years. India is an interesting case study because of its strong economic growth and rapid motorization. Many of the developing countries in Asia, Africa, and Latin America are following a similar trajectory. Therefore, the lessons learned in India will be relevant to many other countries around the world.

(ia) sessions of the conference on the topic of the conference
(ipu) bilateral transportation agreements
exploration applications
(ic) (o) new vehicle design and manufacturing
three-dimensional [4a0]. [

Several challenges need to be overcome in order to realize the potential benefits of ITS. These issues are related to the high cost of the technology, the lack of standardization, and the need for a skilled workforce. The high cost of the technology is a major barrier to the adoption of ITS. The lack of standardization is a major barrier to the interoperability of ITS systems. The need for a skilled workforce is a major barrier to the implementation of ITS. These challenges are being addressed by the research community, and by the industry. The research community is developing new technologies and standards, and the industry is developing new products and services. These efforts are expected to overcome the challenges and to realize the potential benefits of ITS.

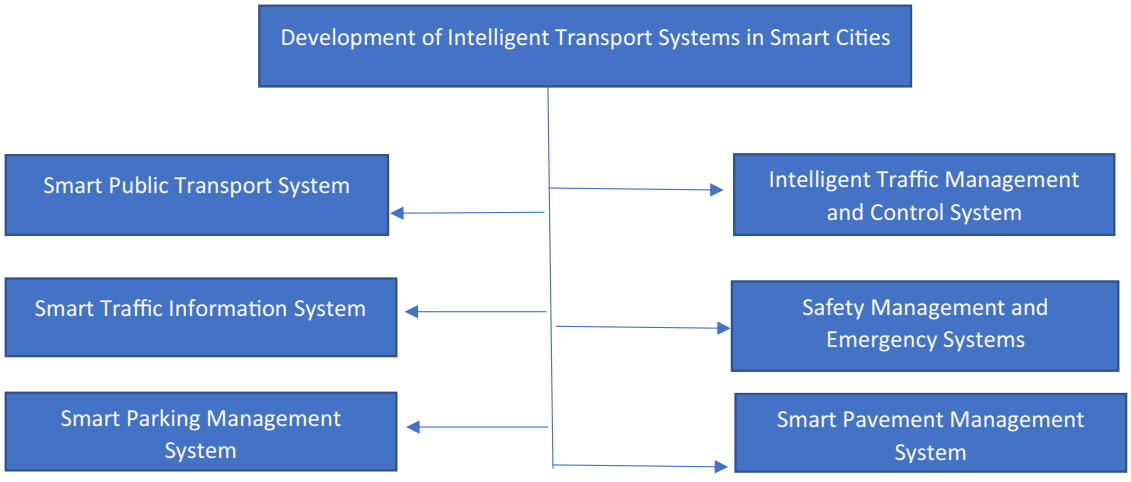

Fig. Various sub-systems of intelligent transportation systems.
(Source: Agarwal, 2015)

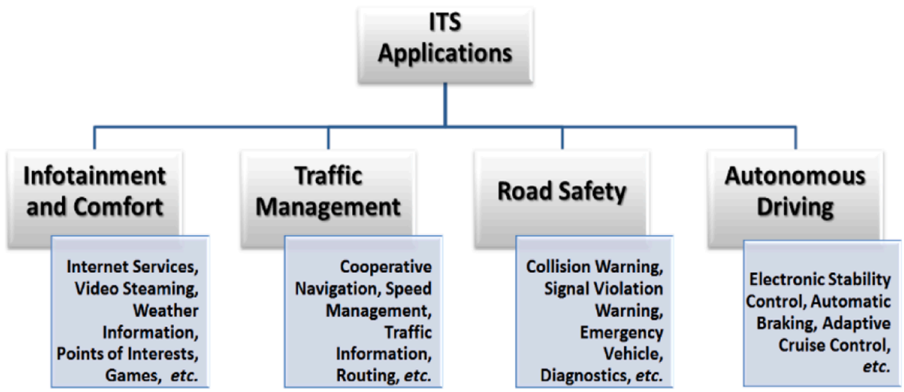

Fig. 3. Classification of ITS applications.
(Source: Hamid et al., 2015 [5])

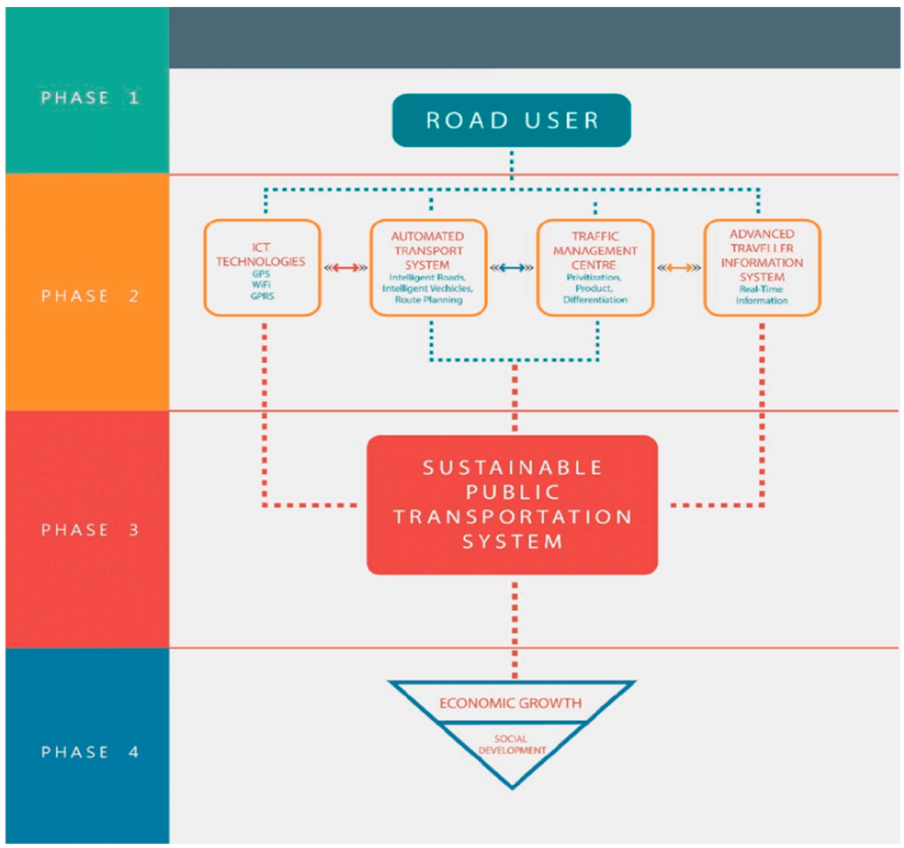

Fig. 4. ITS Framework implementation for public transportation.
(Source: Abe, Oje [55])

1.3 Intelligent transportation

In the recent years, huge volume of data are generated with the proliferation of multiple technologies and sensors. Thus data has become valuable in the decision-making process of businesses, governments and society. Transportation is the lifeline of urban set up can not be left behind in data generation and usage. This sector plays a significant role in urban development as it impacts people, processes and performance. To enable data generation, [illegible] turn has been [illegible] vehicle features of transport [illegible]. Data generated by the devices are monitored by the Government [illegible] business [illegible] generated through various applications. Various innovative applications are being used in transportation in the recent years. The applications focus on a process-oriented systems approach with a closed-loop feedback mechanism to measure the outcome of the solutions related to transport industry.

Transport Management Systems (TMS) are a part of transportation [illegible] specifically in transportation. The objective of these systems is to effectively [illegible] planning, optimization, visibility and transparency [illegible]. According to Gartner, [illegible] expected to grow at a fast pace [42]. Transportation data is linked to information [illegible] system [illegible] administration [illegible] capturing

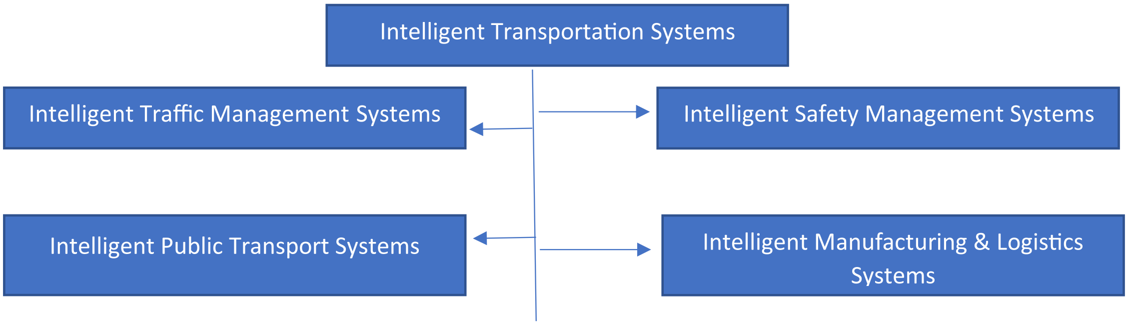

Fig. 5. Intelligent transportation systems.

Table 2
Sub-systems of ITS

Sub-systems of ITS	Description
Intelligent Traffic Management System	Road management on real-time basis to avoid congestion
Intelligent Public Transport System	Transportation of passengers through road along various routes
Intelligent Safety Management System	Ensuring safety of passengers, vehicles, and goods on road
Intelligent Manufacturing & Logistics system	Incorporation of technology in mobile manufacturing and transportation of goods

Source: Author.

processing, maintaining, and managing the data that is generated. Since the past couple of decades, the emergence of technologies, information systems, logistics, mapping, and planning have developed. These systems have provided increased adaptive capabilities in the transportation process, leading to Intelligent Transportation Systems (ITS) [13].

Data generated from vehicles and users is used to build efficient ITS. Building ITS into the transport system ensures increased performance, data collection and integration across vehicles, transport and related activities. The observed ITS supports the decision-making of city authorities and businesses.

The architecture of Intelligent Transportation Systems forms part of Transport Management Systems. A task-based approach has been adopted to set up technologies. Transportation systems use technologies towards building a smart transportation system. Each of these sub-systems of ITS is identified and discussed along with the applications which have impacted the transportation system. Table 2 summarizes the papers covering government and private sector reports. The framework is adopted considering the sub-systems of ITS. This framework helps the businesses and governments to adopt the technology, and the researchers evaluate it under a given scenario.

2. Literature survey

AI has caused significant disruption in various industries like healthcare, banking, insurance, retail, manufacturing and transportation. Several researches have experimented with AI in transportation and found that its market is on an upward trend. With the technology advancement, the transport industry is transforming through the use of embedded devices in vehicles. These vehicles help to build ITS through data generated from the devices.

AI in the transport domain has the ability to resolve problems of time management, transportation planning, scheduling and in-time distribution, logistics and freight management. Some of the other studies suggested AI solutions with multiple real-time application to understand and analyze transportation, pedestrian behavior. AI techniques help in facilitating the application for transport management like vehicle, driver, road, and traffic which is a component of a smart city for transportation [59]. AI methods and solutions are useful in understanding the complex relationship between the characteristics of the transport system [1]. The research study [31] focuses on the land and transport models. Although AI is promising in the transport domain, it also brings in significant challenges to the current world. The private transportation of commercial and personal vehicles in the mid-2000s brought up opportunities and programs with considerable impact on the fields.

A joint research program between the American Public Transportation Association (APTA) and Transit Authority (TA) named 'AI in Mass Public Transit' was conducted through review of literature, case studies, and expert interviews to explore applications [16] of AI in public transportation that the transit community could adopt. The consultancy company PwC undertook an assessment to understand the impact of AI among economic and business sectors, and found that AI improves employees' skills in sectors such as financial services, technology and manufacturing; it was found that young workers are readily adapting to technology related to transportation [48].

Early adopters of AI in the transport sector have shifted their attention towards the mobility [24]. AI is capable of reaching higher performance through technologies that exhibit great potential in producing and developing hardware and software (robots) related to Geo Maps, Data-driven AI, machine learning techniques, AI technologies for searching and analyzing quantified data, helps to mark interdependencies; traffic congestion reduced and pollution emissions; design and manage transport data; travel and pedestrian behavior (Noise, Data Science, Car sharing and Artificial Intelligence in Transportation (2019) [43]). Data and AI driven applications serve major cornerstones to deliver optimal mobility and effective mobility ecosystem, as per the application of many agencies.

Recent developments in AI require real-time generating data for transportation, which increases the growth of data. With the increase in growth of vehicles, there is need for smart traffic management [57].

Some of the key AI functions in transport applications are currently being commercialized as detailed in Table 1.

The study [50] focuses on advanced surveillance systems and traffic management in Intelligent Vehicle-Road Systems. They discuss the non-recurring incidents in complex networks. The other study suggests AI-based solutions with multiple real-time

Table 3
Traffic management.

Intelligent Traffic Management Systems				
Source of data	Issues	Role of AI	Benefit	Previous Studies
Vehicles with Intelligent systems	Increase in cost due to traffic congestion	Machine learning tools to predict traffic flow	Better fuel saving capability and less pollution to environment	Short-term traffic congestion prediction by evaluating traffic parameters achieved using ML models (Akhtar, Moridpour, 2021) [38]
Data from smart phones	Routing	Alternative route suggestions	Time saving	Driver behavior monitoring systems through data generated from smartphones using ML techniques [17]
Intelligent transport systems	Unpredictable traffic congestion	Identification of pollution substances in air	Controlling environmental pollution	Multiple air quality indexes are combined using fuzzy logic along with simulated annealing and particle swarm optimization technique to identify pollution (Liyon, H.B, 2019) [37]
Traffic lights and vehicles	Peak hour traffic management	Realtime tracking congestion algorithms traffic lights	Control of high and lower traffic patterns	Real-time information gathered from traffic lights are observed for optimal green-time distribution before AI-solutions are deployed for analysis [67]
Data from Vehicles	Increase in the number of vehicles on the road	Pattern identification	Better observation and decision making	The ability of AI techniques, specifically ANN is deployed to predict traffic congestion in heterogenous traffic conditions (Olayode, 2020) [44]

knowledge expert systems in traffic management. Two AI paradigms support vector regression (SVR) and case-based reasoning (CBR) are used for the evaluation of a large-scale network and complex simulation model. This study [11] evaluates the outcomes of the two prototypes comparing the predicted and traffic conditions. In this study, agent-based systems monitor traffic incidents and transport activities. The article [22] compares two integrated autonomous agents deployed in intelligent traffic management systems that perform supervision for real-time traffic management in Barcelona.

The study [51] investigates the application of multi-intelligent agents in urban traffic control (UTC) systems. The proposed study uses the multi-agent system to implement optimized UTC for dynamic environment. The output of this model suggests several intelligent agents for traffic signal control. These agents are capable of responding to the environment and maintaining stability and integrity [7].

Technologies related to autonomous vehicles (AVs) have the potential to improve the safety of travel. They ensure reduction in travel time and increase fuel efficiency. Currently, these technologies have become disruptive in the emerging markets of transportation. However, regulations to adopt them by a larger group of people are prohibitive. To promote adoption, Regulations with respect to cybersecurity, liability, data privacy and infrastructure governance have to be made in the market for autonomous vehicles [18]. The study evaluates the effect of low speed autonomous emergency braking systems and found that the vehicles fitted with this technology reduced the rear-end crashes by about 38% [19]. In the current era, major problem in transportation is congestion, partly due to increased mobility. On top, the potential to tackle this challenge lies in autonomous vehicles [36]. These vehicles detect their physical and digital surroundings using technologies [25] and connectivity [68].

Connected and autonomous vehicles have capabilities like smart devices and real-time communication with the car and infrastructure. The cars are multi-sensor systems that support driving operations. These cars ensure the safety and reliability [12]. Primarily recognition systems with image processing algorithms detect and identify cracks in pavement structures. Current techniques are used to identify specific classes of driver behavior (Sadek, Artificial Intelligence Applications in Transportation, 2007) [54].

The article [35] proposes new models and means of forms of manufacturing using technologies to build intelligent vehicles with technology into the manufacturing of automobiles. The study discusses the role of AI technology in business and economics focusing on [15]. The automobile company Ford has successfully implemented AI in its streamlined manufacturing process to improve the quality of the organization. The study focuses on the process of managing the deployment of intelligent systems for manufacturing (Rychtyckyj, Intelligent Systems for Manufacturing at Ford Motor Company, 2007) [52]. The study [64] mentions that the idea of autonomous technologies originated back in 1930. Most of the autonomous vehicles developed by the company Google rely on video cameras, radars, laser sensors, and are developed themselves. Autonomous vehicles would impact the functioning of the individuals, public health and the economy [63].

Manufacturing industries are using the autonomous data to its network capability with the firms and stakeholders. With the transport industry playing a major role in logistics, they are appropriate generated outputs through application of technologies in the operations [27]. Future research can recommend through agent-based model optimization by the process of simulation [39]. The study [45] pondered the fact whether the driverless will have an impact on human. Extreme attention is to be paid to the vulnerabilities in these integrated intelligent systems. These vulnerable systems are susceptible to network collapse, hacks by external agents. The study proposes 5.0 which can democratize knowledge production of Big Data.

The research [62] claims that the transport system's key elements of logistics are provided as separated logistics services. The improvement in transportation logistics is contributing to overall business due to the influence

Table 4
Public transport.

Intelligent Public Transport System				
Source data	Issues	Role of AI	Benefit	Previous Studies
Built-up cross-sectional surface and road traffic patterns	Variability in data	Prediction of train motion patterns through machine learning algorithms	Planning Decision making	Short-term passenger flow prediction using multi-source urban rail transit network traffic data (Akhtar and Moridpour, 2021)
Real-time data of drivers and passengers	Traffic congestion	Optimization of routes	Shortened time of travel	
Alpower-assisted vehicles goods delivery	Variation in delivery time, place	Suggestions on improving driving patterns	Improved productivity and fuel efficiency	Three-objective artificial bee colony algorithm for robust pickup and delivery traveling salesman problem with multiple drones/vehicles (Wang et al., 2020)
Sensors from smart roads	Wear and tear of the road	Automated ticket generation	Road management	A sustainable Stackelberg evolutionary algorithm for real-time vehicle-to-grid scheduling in transportation networks with electric vehicles (Yang et al., 2018)

Table 5
Safety management.

Intelligent Safety Management System				
Source of data	Issues	Role of AI	Benefit	Previous studies
Sensors from Intelligent connected vehicles	Fatigued drivers	Auto-pilot system activation	Avoid accidents	Multiple integrated sensors in autonomous vehicle determines safety and feasibility (Yeong et al., 2021) [16]
Long distance truck drivers	Continuous driving and unknown terrain	Health monitoring	Predicting accidents	Real-time measurement of physiological parameters driver's feedback to cloud and analyzed using Angsing intelligent cab health monitoring system [65]
Self-driving vehicles	Blind spot area, performance and safety issues	Driver data, cruise control, advanced driver assistance systems	Frequent maintenance of sensors	Self-driving vehicles require investment towards safety strategies drivers (Littman, 2021)
Real-time data transmission	Increased time and cost to routes	Optimization techniques to forecast real-time volume	Prediction of vehicle arrival and route knowledge	Autonomous vehicles acquire vehicle location, speed, and state of the vehicle handling safety [21]
Monitoring through sensors	Refueling	Remote control management	Saving fuel, improve mileage	Intelligent visual analysis installed vehicles provide mobility support and tracking mechanism [Lim et al., 2015] [59]

technology. The review was undertaken as a systematic literature review, research on the transportation domain was found to be developed based on the service of logistics and tourism industry only limited to the movement of goods, research on passenger's point of view is also only limited to the movement of goods research and could also not be applied in many countries. Also the use of AI in transportation management is still in the early stage, significant integrated collaboration is required between various stakeholders in the transportation industry. Also the use of AI in transportation management is still in the early stage, significant integrated collaboration is required between various stakeholders in the transportation industry [23,24].

The study [29] incorporated AI technology in the service industry, perspective of review-based knowledge, which is the driving force of service automation and performance. The article was based on large-scale building design, which is given for smart city, machine learning supports intelligent fault diagnosis and prediction, and correspondingly it has a significant role in the logistics and transportation industry [24]. The study is only limited to the logistics industry with the help of transportation; the function of transportation and logistics industry is to reduce the impact of the volume of transportation and, due to adoption of emerging technologies and artificial intelligence, unemployment [30,31].

From the table 4 and 5 it is understood that the application of AI in transportation industry provides significant benefits in the development of transportation industry. The current state-of-the-art development of AI application in transportation management System, Intelligent Public Transport System, Intelligent Safety Management System, Intelligent Maintenance & Logistics System is to combine all these systems, the role of AI and the corresponding benefits [32,33]. Further research could also be done in the transportation industry to overcome the challenges and issues faced in the transportation industry to provide a conclusion to the AI and the corresponding challenges in transportation industry.

3. Frame-work

From the earlier studies, it is understood that AI is widely used in building intelligent transportation systems and it is also beneficial for the transportation industry. The current state-of-the-art development of AI application in transportation industry is only limited to the movement of goods and logistics industry, which is also only limited to the movement of goods and could also not be applied in many countries.

Transportation industry is highly dependent on many other industries, which is related to transportation industry, and it is also dependent on the economy of the country. The transportation industry is also dependent on the economy of the country. The transportation industry is also dependent on the economy of the country. The transportation industry is also dependent on the economy of the country. The transportation industry is also dependent on the economy of the country.

Table 6
Manufacturing logistics.

Intelligent vehicles	Maintenance	Role of AI	Benefit	Previous studies
Intelligent vehicles	Need for maintenance	Connected vehicles collect data	Better predictive maintenance	Reduced costs and improved customer satisfaction
Connected vehicles	Repairs and maintenance	Connected vehicles collect data	Empower drivers to improve their driving	Connected cars leverage their access to the car manual to help drivers with vehicle functions (Ananda Kumar and Ruiz Garcia, 2019) [21]
Vehicle fleet with technologies	Increase product and delivery	Shared data across vehicles	Improve visibility	Connected cars leverage their access to the car manual to help drivers with vehicle functions (Ananda Kumar and Ruiz Garcia, 2019) [21]
Network based structure	Large number of manual data entry	Based systems streamline	Aspects of	Smartphone enabled connected vehicle processes (Kwak et al., 2017) [
Invoices and documents	Anomalies in compliance verification	Reserve, detection	Highlevel accuracy	
Contracts	Extraction of information	Natural language processing	Extraction	

Table 7
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Applications	Organizati	Country
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Table 8
Adoption of AI by transport corporations.

State Transport Corporation	AI application	Benefits
Bangalore Metropolitan Transport Corporation	AI cameras, GPS trackers, Face Recognition	To monitor driver behavior related to overspeeding and work
Karnataka State Transport Corporation	Sensors at the front bumper of the bus where the driver waves every 3–4 min	Sensors cut off the accelerator if the driver does not wave at the sensor on long distance luxury buses
Metropolitan Transport Corporation (Chennai)	Intelligent Traffic management system	Automatic number plate recognition cameras powered by OCR reads traffic violation. Automatic generation of challan for payment of fine which is sent to the violator
Uttar Pradesh State Transport Corporation	Anti-collision system	Continuous monitoring of driver for objects within 180 m range by beeping
Maharashtra State Transport Corporation	AVD&CNext AI Canadian companies	Set up AI cluster for various projects including transport–investment in R&D, Technologies for transport
Telangana Transport Corporation	Chatbot for customer support	AI answers multiple questions. Difficult question is forwarded to higher authorities
West Bengal Transport corporation	Path Disha–AI app	Availability of specific buses, estimated arrival time of buses. Track behavior. Commuter feedback and behavior
Toronto Transit Commission	Self-driving shuttle	Supervised by human drivers. Initially, it was to test the connectivity to public transport
French National Railway Company	Chatbot for transit passengers	Helps travellers plan their daily trip and navigate across the city in the event of inevitable delays
Road and Transport Authority, Dubai	Smart and sustainable transportation–AI: Automatic Bus Track Control System, Smart pedestrian signal system	Monitoring the condition of bus drivers–fatigue, surveillance across vehicles. Improvement of bus efficiency, sensors allocate pedestrian signal crossing
Ministry of Transport, Singapore	nuTonomy–self-driving car company partnering with Grab to make autonomous taxis	Self-driving vehicles are being tested with the aim to improve public transport
Transport for London	Shares open data to private providers	Road traffic, performance and planned road works to reduce congestion and road management

2, some of the activities in public transport are traffic management, parking management, payment management, and safety management. Through ITS, commuters, transport operators, and the citizens overall are benefitted.

The study undertaken by Hamid et al. 2015 [5] classified the various applications of Intelligent Transport Systems (ITS) into four main classes as given in Fig. 3. They are

(i) Information and comfort;
(ii) Traffic management;
(iii) Road safety; and
(iv) Autonomous driving.

These applications are listed for the vehicles to improve their utility thus ensuring safety and enhancing the public transport facility. These applications generate data which assists in the decision-making process by the government authorities to maintain a public car in a better manner. Some of the applications are to improve passenger comfort, provide a better experience, and efficient management.

The ultimate benefit of Intelligent Transport System is to the road users. The Intelligent Transport System (ITS) framework sustains public transportation. ICT technologies, automated systems, traffic management and advanced traveller information systems [60]. The framework in Fig. 4 presents the flow of information from the road users as the source of data to origin leading to the utilization of the information through ITS applications. Applications are built up to transport the beneficiaries who generate data. Once the application is built up in ITS, they not only improve the efficiency of the public transport system, but also contribute to the sustainability of the transport system and to economic growth.

Some of the applications which are built in ITS are traffic management, traffic control, vehicle navigation, smart parking management, etc. To implement the ITS requirements of technology with operational and elaborate infrastructure (such as Green Fins, 2010 [96]). The classification of problems in ITS discussed by [29] include performance monitoring, traffic management, improved transport operations, supporting the movement and transport infrastructure management.

ITS follows a top-down approach, to go through the literature and study considers the sub-systems of ITS as classified to explore the benefits of AI solutions. The programme applies to each of the sub-systems which are considered for the study given in Fig. 5. These sub-systems of Intelligent Transport System (Table 2) are derived from the various works on the previous studies. Classifications are derived from the previous studies and the AI solutions built in ITS. The sub-systems proposed in this study summarise their activities in ITS.

Each of the sub-systems given in Fig. 5 are classified based on the origin of transport data and organised in a systematic manner. Further, the role of technology to solve the issues are highlighted in the study. The organisations that adopted AI successfully are listed. A compilation of various transport corporations which have implemented AI solutions is listed. The adoption of AI in transportation related studies is done.

4. Discussions

4.1. AI solutions in Intelligent Transportation

The contribution of AI to the field of transportation has been immense and extensive. These solutions include autonomous vehicles, traffic management, optimized routing and logistics, providing safety for vehicles, driver assistance, and the generation of travel demand which has been achieved through AI technologies.

The current study focuses on sub-systems of transportation, namely Intelligent Traffic Management System, Intelligent Public Transport System, Safety Management System and Intelligent Freight & Logistics System. Tables 3–6 describe the various AI solutions used in these sub-systems, and the benefits achieved.

From Table 3, we observe that AI provides solutions to transportation issues by suggesting alternate routes, real-time tracking, and traffic lights during traffic congestion. This helps to manage traffic in an efficient manner, eventually reducing environmental pollution and building sustainable cities.

From Table 4, we observe that provision of less time consuming public transport and other transportation facilities are the main factors, namely, negative, and the rate of change is not as high as the other factors. This study suggests that efforts should be made to reduce the time consumed for commuting from the residential areas to the workplaces. Private transport facilities should be discouraged and effective public transport facilities should be provided to the commuters. The study suggests that the government should provide more and more public transport facilities to the commuters in order to reduce the number of private vehicles on the roads. The study suggests that the government should provide more and more public transport facilities to the commuters in order to reduce the number of private vehicles on the roads.

From Table 5, we observe that the sub-criteria number of accidents, driver's behavior, and traffic violations are the most significant factors affecting the transportation system. The study suggests that the government should provide more and more public transport facilities to the commuters in order to reduce the number of private vehicles on the roads. The study suggests that the government should provide more and more public transport facilities to the commuters in order to reduce the number of private vehicles on the roads.

From Table 6, we observe that the sub-criteria number of vehicles, number of accidents, and number of traffic violations are the most significant factors affecting the transportation system. The study suggests that the government should provide more and more public transport facilities to the commuters in order to reduce the number of private vehicles on the roads. The study suggests that the government should provide more and more public transport facilities to the commuters in order to reduce the number of private vehicles on the roads.

4.2 Application of the model

4.2.1 Application to various organizations

Application of the model to various organizations is discussed in this section. The model is applied to the transportation system of the city. The model is applied to the transportation system of the city. The model is applied to the transportation system of the city. The model is applied to the transportation system of the city.

4.2.2 Application to public transportation

Application of the model to public transportation is discussed in this section. The model is applied to the transportation system of the city. The model is applied to the transportation system of the city. The model is applied to the transportation system of the city. The model is applied to the transportation system of the city.

5. Conclusions

The study has been carried out to identify the factors affecting the transportation system of the city. The study has been carried out to identify the factors affecting the transportation system of the city. The study has been carried out to identify the factors affecting the transportation system of the city. The study has been carried out to identify the factors affecting the transportation system of the city.

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