REVIEW ARTICLE

Significance of artificial intelligence in the development of sustainable transportation

Dhulasi Priya S* and Saranya K G

Abstract

The idea of Sustainable development has gained more attention since it involves satisfying needs without degrading the environment. Sustainable development has many targets across various subjects, in which Sustainable Transportation is one of the cores to sustainable development. The objective of sustainable transportation is to achieve social, environmental and economic growth with universal access, enhanced safety, improved resilience and infrastructure, reduction of emission in greenhouse gases, traffic management, and freight management by different modes of transportation. It is vital and interlinked across several sustainable development goals (SDGs) and targets in the 2030 Agenda proposed by United Nations. There is a need to improve sustainable transportation, which can be achieved through artificial intelligence (AI) as it helps the sector to increase public transport, traffic safety, reduce accidents and improve traffic management, decrease carbon emissions, rise reliability and also leverage economic growth through methods like Fuzzy logic (FL), artificial neural networks, Ant Colony Optimiser, Genetic algorithms, Swarm optimization algorithm, simulated annealing. Big data analysis, the Internet of Things (IoT), and robotic process Automation also support it. This paper addresses the overview of the importance of sustainable transportation along with the role of AI in different modes of transportation, the current level of sustainability across the globe, and progress in transport systems and concludes with challenges and future improvements that can be made towards the goal.

Keywords: Artificial Intelligence, Development, Sustainable development goals, Sustainable transportation, Transport.

Introduction

Sustainable development means meeting the needs of the present generation without compromising the future generation's needs by protecting the environment with moral and financial development. It has become a concern for everyone across the world. Sustainable development gained global attention when environmental degradation, social inequality, and financial crisis turned huge (Wikipedia). In the year 2015, United Nations General Assembly consisting of 193 members from different countries, proposed Agenda 2030 for sustainable development goals (SDGs). There are 17 goals and 169 targets for these goals which are

interlinked and are measured with definite indicators. These are designed by specialized teams who are experts from different streams, social activists etc. and to be followed by all countries (Wikipedia). Sustainable transport is one among the 169 targets set by United Nations.

Transportation refers to the movement of people, goods etc., from one place to another, which can be accomplished by different means of transport. The four main modes of transportation are maritime transport, road transport, air transport and railway transport which has freight transport as well as people mobility transport. Transportation has now emerged as one of the critical industries as it helps in employment, transporting goods and enlarging trade sector, supporting tourism, people traveling, automobile manufacturing and logistics (Wikipedia).

Sustainable transport is important as its motto is to provide amplified safety, enhanced resilience, universal accessibility and affordability to communities in rural and urban areas. It also helps in enhancing the environment and in reducing climate impact. It also indirectly helps in eradicating poverty, improving livelihood and infrastructure, empowering women, enlarging access to quality education and health care, and dealing with climate change. It is crucial for attaining the SDGs by the year 2030 and Paris Climate Change Agreement. All these goals and targets are interconnected (sdgs.un.org). The SDGs connected

Department of Computer Science and Engineering, PSG College of Technology, Coimbatore, Tamil Nadu, India.

*Corresponding Author: Dhulasi Priya S, Department of Computer Science and Engineering, PSG College of Technology, Coimbatore, Tamil Nadu, India, E-Mail: 21mz01@psgtech.ac.in

with it directly are SDGs 9 on Industry, Innovation and Infrastructure, which deals with developing sustainable, resilient, reliable, quality infrastructure across the globe, including regional and transborder. At the same time, it is associated with SDGs 3 on Good health and well-being, which aims to reduce the number of deaths and injuries in road traffic accidents. In contrast, it is linked with SDGs 11 on Smart cities and community infrastructure to support community well-being and economic growth with all people acquiring equal access, safe and affordable transport system. It also has an indirect impact on SDGs 13 Climate action in regards with reducing global warming by controlling the emission of greenhouse gases like CO_2 (sdgs.un.org)

The progress level in sustainable transport is low. Still, nearly a billion people do not have access to all-weather roads, and no proper transportation, including public transportation. Approximately only 50% of the world's population in urban areas have public transport in good condition. The death rates in road accidents are high. In contrast, nearly 8258 million tonnes of CO_2 is emitted globally due to transportation, accounting for 25% of total CO_2 emissions (Sustainable transport, sustainable development). The traveling rate is also higher with environmental degradation. In addition to this, building resilient infrastructure and transport system is difficult due to frequent changes along with extreme weather conditions.

Sustainable transportation can be achieved efficiently and quickly by using current day technologies like Artificial Intelligence(AI). It is a disruptive technology that imitates cognitive skills of humans like learning and problem-solving and is done by computer or machines. It has taken exponential growth due to the availability of large sources of data along with the accessibility of compatible hardware and software and efficient network infrastructure. AI helps analyze and predict uncertainty in complex problems in reliable and cost-saving ways. The advanced and constantly developing AI algorithms like deep learning techniques, convolutional neural network (CNN), artificial neural network (ANN), machine learning, automation, and natural language processing have paved ways in transforming various traditional sectors and has also helped governments in building sustainable smart cities that preserve biodiversity and community well being (Abduljabbar *et al.*, 2019).

Many countries like United States, Australia, China, Russia have started transforming transport system with AI. India has also started its focus on IoT, AI, big data via Digital India Project. There are automated mapping and satellite technologies, self-driving cars, air quality checker, traffic controller and crowd management techniques, Fleet management, Enhanced public transportation, efficient bridge and road construction and monitoring the road conditions, pedestrian detection, computer vision powered parking etc. which uses AI for development (www.v7labs.

com). This paper gives an overview of achieving sustainable transportation through AI techniques.

Following the Introduction, this paper has Section 2 on the Literature survey which consists of different techniques and ideas on AI in transport and its applications, Application of AI in Road transportation, Maritime transportation, Railways, and Flight transport. It's adoption by different organizations and government transport corporations is discussed in Section 3. This section also discusses the safety measures, ideas of enhancing public transportation, and improvements to be carried out. The conclusion of this paper is given under Section 4.

Literature Survey

This chapter reviews various techniques and methods in AI available in the literature, which helps enlighten sustainable transportation.

Ricardo Vinuesa *et al.* (2020) paper's work was carried out on the AI role in achieving sustainable development goals. This paper concludes that using AI , 134 targets across all the 17 goals can be accomplished using a consensus-based expert elicitation process but it inhibits 59 targets in sustainable development.

Interagency report for second Global Sustainable Transport Conference in 2021 projects the full report on different perspectives like social, economical and environmental impact. It also includes accessibility, safety , affordability, reduction in CO_2 emissions, climate change, transportation improvements, governance improvements, and automating processes and vehicles. The suggestion on focus area is to improve transportation in rural areas and research and development must be fast-tracked to improve existing solutions and identify new ones (Sustainable transport, sustainable development)[2].

Abduljabbar *et al.* (2019) [3] presented an overview of the applications of AI to a variety of transport-related problems which focused on a number of application areas which are expected to have more influence in smart cities, including automated vehicles, improving public transport, future traffic status prediction, disruptive urban mobility, traffic management and control and automated incident detection. AI techniques facilitate generating a selection for challenges in increasing travel demand and reducing CO_2 emissions.

Maria Niestadt *et al.* on AI in transport proposed the possibilities of current and future developments, opportunities and challenges in sustainable transportation. It focused on the steps devised and taken by the European Union to adapt their regulatory framework to the new technological developments such as AI, IoT, which support innovation and ensures community morals hand-in-hand. This paper also states the measures already taken that support the innovations in transport systems using AI (Niestadt *et al.*, 2019).

Lakshmi Shankar Iyer [5] has proposed a study on AI-enabled applications towards intelligent transportation aimed to discuss the roadmap of building a sustainable society using the applications on AI in which public transport, traffic management, Manufacturing and Logistics, safety management are the four subsystems analyzed and role of AI and its benefits are captured (Iyer, 2021).

Sustekova (2015) published a paper on how AI is used in traffic management applications. The artificial neural networks and basic elements of them are defined and the reason for using them in transportation problem solving, the probability of using neural networks in road transport, pros and cons of using them and various related tasks solvable by neural nets were discussed in this paper.

Wu and Wang (2021) proposed a concept of research on green transportation mode of Chinese Bulk Cargo Based on Fourth-Party Logistics. This paper dealt with advancing China's bulk cargo green transport using fourth-party logistics which helps in cargo transferring from road to rail in addition to cut down in transport cost and carbon emissions with the help of Machine Learning Algorithm and particle swarm optimization.

Anandakumar*et al.* (2019) [8] proposed work on Intelligent Vehicle System Problems and Future Impacts for Transport Guidelines. This paper analyzes the advancements in autonomous vehicle technologies with both opportunistic and challenging perspectives. It is found that it has capacity to reduce cost and improve accessibility to people of all classes and topography.

Ianculescu *et al.* (2019) gave an overview of reshaping digital public services using intelligent technologies. He also proposed the idea of integrating different types of public services. This paper gives an AI-based architecture model of public services which are citizen-centered. It is modeled by combining capabilities of intelligent technologies and real-time input from public and private sectors stakeholders like citizen, authorities etc.

Wang *et al.* (2019) dealt with network traffic speed prediction in urban transportation. The proposed model is a deep learning framework based on path using a bidirectional long short-term memory neural network where road networks are separated into critical parts so that the high dimensional traffic data are separated properly and modeled. This model is also analyzed in a road network with 112 road segments.

Increase in the requirements for transport services can be dealt with with extensive approach like construction of roads, bridges, subways, tunnels etc. and with intensive approach like optimization and management of transportation flows using modern technologies (Katerna , 2019).

He *et al.* (2021) [18] applied a three-level Analytic Hierarchy Process (AHP) structure which is a method to organize and analyse complex decisions with maths and psychology. They constructed comprehensive indices which contains 14 quantitative indices and 8 qualitative indices for evaluating the multimodal freight transportation network in the rail-based development. The indices covered the rail-based infrastructures, freight transport performance, transport sustainability, and multimodal transport capability.

Xie *et al.* (2022) proposed research on the cross-border logistics paths optimization of the "Belt and Road" in the Inland Regions used AI solution of genetic algorithm to optimize logistic cost, carbon emissions, and logistic time. This optimization has helped in reduction of carbon emissions.

Li *et al.* (2017) reviewed AI applications in the manufacturing industries. This proposed new means, models and forms of vehicle manufacturing using various AI and machine learning technologies. And will be useful in manufacturing less fuel-emitting, efficient vehicles. This study is useful in building technology adopted intelligent vehicles with in automobile manufacturing.

Guerrero-Ibáñez *et al.* (2018) proposed a study on Intelligent Transportation Systems with Sensor technologies proposed smart roads with sensors by integration of sensor technology and infrastructure of transport. Passenger and vehicle safety is also considered in this study. These smart roads detect the wears and tears of the road and generates automatic alerts to officers near that zone.

Ahmed *et al.* (2022) proposed a system based on technologies of blockchain, internet of things (IoT) and AI which assist and protect the smart applications used in IoT based sustainable transportation and smart city. It also provides digital analytics and securely stores it in cloud repositories using blockchain.

Pamucar *et al.* (2022) assessed and studied a metaverse-based model using approaches like an ordinal priority and Aczel- Alsina.It gives an implementation on multiverse and considers transportation in public, autonomous driving, sharing economy and traffic operation. These are evaluated and grouped based on operation, efficiency, legislation, regulation, and social and health.

Sustainable transportation

Significance of Sustainable Transportation in Sustainable Development

Sustainable transport is key to sustainable development because of its impact across different SDGs. It is crucial for achieving the 2030 Agenda for sustainable development and the Paris Agreement on Climate Change[12]. With changes in conventional systems in transport, notable challenges exist in achieving full transition towards sustainable development. Mobility of people and goods are facilitated by sustainable transport, which also helps generate jobs, support livelihood, and eradicate poverty. It also contributes to aiding health, education, finance, improving inclusive

Table 1: SDG Goals and Targets related to Sustainable transport

S.No.	SDG	Targets	Indicators
1	Good health and Well-being	By 2020, halve the number of global deaths and injuries from road traffic accidents Indicators	Death rate due to road traffic injuries
2	Industry, Innovation and Infrastructure	Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	Proportion of the rural population who live within 2 km of an all-season road Passenger and freight volumes, by mode of transport
3	Sustainable Cities and Communities	By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities

economic growth, empowering women and vulnerable groups, enhancing well-being and living.

Improved road access in 15 villages in Ethiopia helped in reducing poverty by 6.9% and so in Pakistan strong correlation between poverty and poor rural connectivity lead to difficulty in access to education and health services have been identified from World bank data (Sustainable transport, sustainable development). The subsidiary in public transport also has shown improvement in poverty reduction and accessibility to all. Reconstruction and Re-establishment of road by making investments in their infrastructure has resulted positive influence on society and economy in South Tarawa (Sustainable transport, sustainable development).

On considering the interconnections of Sustainable transport with other SDGs and its respective targets, Steps and Measures on planning, investment and implementation should be taken by everyone mainly subjects like stakeholders, non-government organizations(NGO) and government for accelerating the betterment towards sustainable development (Sustainable transport, sustainable development).

SDGs and the targets related to sustainable transport is given in Table 1.

AI in different modes of transportation
Transportation systems have complex characteristics; to manage them efficiently and bring resilience, we need smart solutions. *AI* which is blooming across different fields can serve this purpose. AI does not refer to one specific technology, but to a wide range of diverse methods, technologies and approaches. AI techniques can be implemented in vehicles used in different modes of transport, in traffic monitoring, for ensuring safety and reducing accidents, in automated vehicles, traffic detection, transport design, to reduce

CO_2 emission , for planning and construction of transport infrastructure like bridge, railway tracks, roads, stations, pavement etc. It helps in making transport systems smart, safe, clean and comfortable. Several studies are conducted to overcome issues in transport systems, including applying AI in transportation, which has helped in development. How AI is applied in different modes of transport is discussed in the subsequent sections.

Road Transport
Road transportation plays a vital role in connecting rural areas and door to door flexible services. The self driving cars built using technologies like computer vision techniques for detecting objects. It decodes and recognizes the visual data which makes the vehicle capable of driving on its own. It requires consistent feeding of huge amount of data to train the model and make it reliable. It helps in preventing car crashes, increasing efficiency, saving of fuel, reducing strain for people driving for long distance. According to Mckinsey, The operating expense can go down by 45% by using self-driving trucks (constructible.trimble.com). Most of the automated vehicles developed by Google depends on their services like Google maps, sensors, video cameras, range finders with lasers But all these are in testing process.

While bulk cargo transport structure promotes the transfer of cargoes from road to rail which reduces the carbon emission and cost reduction , this is modelled by fourth-party logistics by improving the particle swarm optimization algorithm Wu and Wang, 2021). We also have truck platooning systems which involves several heavy goods vehicles coupling within minimum distance of each other using automated support system for driving and connecting technology and allows them to automate and accelerate or brake simultaneously. It requires drivers in all vehicles but only the leading vehicle is driven by a driver and other drivers are needed to handle complex situations . This helps in limiting fuel use, efficient driving, automatic braking, vehicle detection and emissions of CO_2 [2].

Delay predictions is an additional advantage which includes techniques like leveraging data and computer vision. The transportation companies with the help of delay predictions can offer a seamless and extraordinary services to passengers by reducing the waiting time of the passengers and elevating their journey experience.

While drone taxis which does not require pilots in helicopters and provides a unique and complete solution to tackle with different difficulties like emission of carbon, traffic congestion etc.

One of the extensive use of AI algorithms are in road transport services shared economy platform like ridesharing Uber platforms which provides services using various AI techniques such as optimization of routes, matching riders. Experiments are done on Computer vision and Pattern Recognition along with machine learning algorithm in

pedestrian detection and has got decent accuracy level and parking management which already came into existence in some cities and towns for detecting occupancy of lots of vehicles. This computer vision algorithms are helpful in road condition monitoring to identify potholes and to find how much road damage is there which in turn helps concerned authorities to take actions and enhance road maintenance. Image processing and Pattern Recognition also aids for finding cracks in bridges and pavement structures and automatic incident detection. Cruise Control systems, low-speed automated emergency braking systems are developed to mitigate rear-end collisions which is one of the frequent crash type. The overview of application of AI in different sustainable transportation is given in the Figure 1.

Traffic Control

Traffic control has been a major issue and there are several studies on managing this as it lessens pollution to environment and better fuel capability. Traffic congestion can be controlled by using AI clustering algorithms like Fuzzy C-means, K means, Density based spatial clustering of applications with noise for evaluating various traffic parameters. Fuzzy logic along with simulated annealing and particle swarm optimization are used to identify air pollution. Traffic detection , traffic flow analysis, automatic traffic incident detection are some of the AI powered techniques for minimizing traffic. Neural networks are also used in devising new methods to support traffic control (constructible.trimble.com).

AI is helpful to control the traffic flow in road and also devise an approach to reduce the consumption of fuel by vehicles, improving the air quality by reducing emissions of carbon, self driving vehicles, idling of the vehicles when remains stationary. But all these may also lead to more individual transportation like cars than public transportation. This leads to growth in congestion and air pollution. In addition to this, privacy of data and cybersecurity has also to be taken into concern while developing methods with AI.

Figure 1: Applications of AI in different transportation

Safety Control

Using multiple integrated sensors from intelligent vehicles, drivers getting fatigue and tiredness are alerted and accidents are avoided. Driving trucks for long distances is difficult for drivers as it involves continuous driving hours and monitoring the health of drivers will be helpful in predicting accidents (Iyer, 2021) .

Construction and Maintenance of roads and bridges

360^0 camera-equipped vehicle records every angle in video footage and uploads it to cloud , and AI based algorithms remove anomalies. It helps eliminate the burden of referring long hours of footage to detect road damage and also satisfies both technical and business needs by improving accuracy in visual checking of road, speed,quality and predictive maintenance with reduced cost.

Inspection of bridges can be done by using drones which captures variety of pictures of concrete structure. All these help reducing risk factors of manual inspectors and human errors by demographical studies, determination of suitable design life , road requirements, configuration of truck load, number of lanes, where and what tests to be conducted, Collection of samples and field data for geotechnical investigation, determining the livelihood of population, plants and animals of that surrounding, requirements of raw materials like steel, concrete, wood, timber, and estimating resource efficiency, time and cost and insight about performance of constructed roads, bridges etc. (analyticsindiamag.com).

Developed countries have already entered AI-based technological improvements while developing countries like India are still trying to enter. AI and Civil engineering together can help in building roads in precise manner [29].

There is a growing demand for labour. On the other hand, many countries underutilize technology and deliver low production. According to statistics by Bureau of Labour Statistics in U.S. ,BLS, the requirement of construction workers increased from 200,000 in 2017 to 856,000 in 2021 (constructible.trimble.com). Google maps also helps in navigation and finding places and routes, and check traffic.

Railways

Railways are the sole and significant ways of trade and transposition in many countries. It accommodates and offers services to people of different regions for long distances by a cheaper means.

Railway digitalization includes more sustainable trains, fast and flexible manufacturing and testing, monitoring and maintenance by predicting cost, time and other resources, creating an integrated ecosystem, and predicting delays and service disruptions. All these features are supported by using AI. Enhancement of safety through detecting hazards, signal aspect, level crossing and driver advisory systems like obstacle detection on the track , optimizing
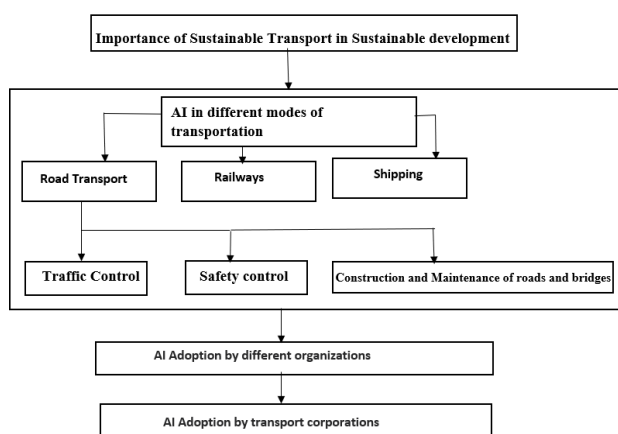
the intervention of human for sensitive decision making operations, and predicting train traffic are all supported by AI. Railcar Inspection Portals powered by Neural networks help in imaging 360⁰ and gives situational awareness, process inspection and security (analyticsindiamag.com).

Many proposals and plans are already going on to develop semi-autonomous and fully autonomous trains. Even the prototype for driverless trains is being developed, requiring AI to detect signals and obstacles in the railway tracks. It requires the integration of sensors, radars and cameras in hardware requirements and support of deep learning approach in AI and computer vision for software (Niestadt *et al.*, 2019) .

Other AI involvement in railways include operational and asset management areas where maintenance and monitoring can be learnt beforehand and critical damages can be prevented. For example, electrical damages can be notified before the possibility of occurrence.

Shipping

Shipping is one of the best mode of transportation for transporting bulky goods, it ensures safe travel with smooth sailing and cost-effective for long-distance traveling across countries.

The shipping industry with AI enhances the routing by predicting the best route to consider the availability of fuel and consumption of minimum fuel along with weather conditions. The role of AI also prolongs with optimized maintenance, enhanced security and safety, forecasting the performance by the rate of degradation due to underwater fouling. Automated equipment which analyses the historical data and shipping seasons. All these automated processes helps in identifying problems beforehand and gives time to adjust the problem and find the solution (analyticsindiamag.com).

AI-assisted vessel helps to foresee the most well-structured way to utilize fuel and operate ship on a destined route. It takes into account different parameters like weather conditions, tides and currents, shallow water etc.

Smart ports are also blooming with more tasks completed effectively and efficiently with the use of AI. The Rotterdam port in Europe is already applying AI to estimate the ship's arrival and departure time and this has decreased the vessel's waiting time at port (Niestadt *et al.*, 2019) .

AI Adoption by Different Organizations

Some of the organizations in United States like Local Motors use a cognitive self-driving electric shuttle powered by IBM's Watson IoTs, Otto(Uber) use an autonomous truck for goods delivery, Surtrac from Rapid Flow technologies is a real time AI based traffic signal control which optimizes performance, improves traffic flow, lessens waiting time and pollution, reduces congestion while the intelligent road freight locomotives attached with sensors to detect objects in and

around the track reduces locomotive failures. This is followed and managed by Germany's transportation in Germany. In China, Finland, Singapore, despite non-uniformity in traffic, weather, and infrastructure, autonomous buses deliver packages, accommodate people and reaches destination on time (Iyer, 2021).

AI Adoption by Transport Corporations

AI cameras, GPS trackers, Facial recognition to monitor driver behavior is already in use by Metropolitan Transport Corporation, Bangalore. On the other hand, In Chennai, an intelligent traffic management system automatically recognizes number plate using Optical Character Recognition(OCR) of computer vision and the violator are fined automatically. Anti-collision system to continuously monitor driver within 180m range for objects implemented by State Transport Corporation of Uttar Pradesh using computer vision of AI. Patha disha which is a free utility AI app for passengers using multi-modal public transport to check seats availability on specific buses, to estimate the arrival time of specific buses, for tracking, feedback etc. is in use by West Bengal transport corporation (constructible. trimble.com). Automated bus track controlling system and smart pedestrian signal system using AI computer vision along with pattern recognition to monitor the condition of buses, fatigue of driver, bus efficiency improvement, to allocate sensors for pedestrian signal crossing by Road and Transport Authority in Dubai.In Singapore, The ministry of transport is trying to make autonomous taxi , freight vehicles and self-driving vehicles. London transportation maintains road traffic, performance of bus, management of road, reduce congestion etc. using AI computer vision, and machine learning algorithm (Iyer, 2021).

Our role on Sustainable Transportation:

The small changes that we can bring in our daily life to accomplish our vision of sustainable transport is using public transport like buses, trains, vans etc. or ride-sharing whenever possible. For instance, if only one person is traveling by car, that person can instead travel in public transport, reducing traffic congestion, decreasing fuel usage, and improving social well-being. If the place to be visited is nearby then instead of using motor vehicles, one can reach by walk or by cycle. Vehicles of all kinds ranging from light weight to heavy weight should use machinery parts, engines, motors etc. to be designed to utilize fuel effectively and produce less CO_2 emission. Obsolete vehicles' materials and metallic parts can be reused or recycled instead of being disposed of. This helps in conserving our renewable resources. AI can be implemented in manufacturing cars to avoid human errors and to complete simple repetitive tasks which helps manufacture vehicles quickly. Also the functions like providing the analysis of driving, driving condition, sending alerts for wearing seat belts, forward

collisions, lane departures, less fuel availability. We should start using electric vehicles and fuel from non-renewable energy sources like solar, wind instead of relying on renewable sources.

Future of AI in transport system

Deep learning technology is used for understanding pattern and predicting future in various fields owing to the availability of enormous data. The capacity to store large data, accuracy and complex data-solving ability are the features that increase the AI market's net worth ever. Its application on social media platforms like Facebook, Instagram, Twitter is well known. Recently, the healthcare sector is also embracing AI for providing better facilities to patients without much difficulty. Likewise, AI can be utilized in transportation systems for the growth of business and the economy (Abduljabbar *et al.*, 2019). It can be useful in providing better map routes for travelers and logistic services. A European company was able to accomplish better truck performance and driver behavior by using sensor information (Abduljabbar *et al.*, 2019). Weather prediction by AI can be used in air transportation system to reduce ticket cancellations as well as avoid any mishappenings. Decreasing traffic jams and well-planned scheduling of public as well as private buses and trains are among other benefits of using AI driven prediction. In addition, self-driven cars that are promised to be on roads before we know it would be the latest application of AI in transportation systems. In addition to roads, AI can also benefit the sea transportation system. Efforts are being made to use AI to collect data and analyze it for better understanding of transportation schedules, traffic and association with logistics for better performance (Niestadt *et al.*, 2019) . Machine learning methods can manage routes, traffic and predict weather conditions for safer traveling. Most countries have now begun implementing AI-based technologies for better transportation systems. Why should India lag behind? It is a country with over 140 crore population and huge traffic system. It is high time that investments must be made to apply AI in transportation systems.

Conclusion

The benefits and capabilities of AI in transportation, which helps us move towards achieving sustainable development. This article also discusses various improvements and needs that can be satisfied by implementing prolific AI technologies and machine learning algorithms. For instance, nowadays, the prediction of congestion in traffic and route management uses machine learning algorithms.AI adoption in transportation requires good leadership, long-term vision, support of the respective transport management corporation. It can also be seen that developed countries have already started using AI-based systems in transportation, while many developing countries

are still trying to implement AI-based systems. This can be due to reasons like large population and insufficient knowledge in technological advancement. Apart from all this, an effective AI solution can be built only with huge amount of data which can be text, audio, image or video, without redundancy and insufficiency (Iyer, 2021). Many of the AI solutions are still conceptual and need real time implementation and analysis of risk factors involved.The fully automated vehicles and other detection systems should give accurate results and ensure safety. Investment in study of technologies and research will surely help in finding different AI solutions in the field of transportation and helps in achieving sustainability.

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