Artificial Intelligence Applications as a tool for facing Sustainable Development Challenges in the Transportation Field

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Abstract. Artificial intelligence (AI) is considered one of the important tools that may change the face of the future due to its high capabilities and extreme accuracy in performing tasks. Cities and settlements of all sizes and locations may benefit from using AI systems to address the different urban challenges. AI is not specific to one field or one technology but it has numerous applications for more sustainable development.

Transportation field is one of the fields that can benefit in different ways from using the artificial intelligent applications and the aim of this research is to study how the applications of AI in the transportation field can be a tool for facing the challenges that reduce the ability of achieving the Sustainable Development Goals (SDGs) in cities. This research handles the topic in terms of three themes. The first theme handles the Challenges that face the transportation field which hinders the achievement of sustainable development goals. While the second theme handles the applications of AI that concern Transportation. And the third theme is studying the relation between the first two themes by a questionnaire presented to experts in four fields concerning (Planning, Transportation, Environment and Technology). The research has proved the presence of very high relation between using the applications of AI in the Transportation field of Cities and achieving the sustainable developing goals in these cities.

Keywords: Artificial Intelligence, Sustainable Cities, Transportations, Sustainable Development Goals (SDG), Sustainable development Challenges.

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Introduction

During the previous decades, there were a lot of efforts and initiatives to move forward towards achieving the sustainable development goals (SDGs) in cities but there were always a lot of challenges that limits this aim. These challenges are concerning global and national reasons. The Transportation field is one of the fields that face a lot of challenges.

Traditional methods to deal with these challenges are not effective hence it is not fast and not accurate and suffer from the lack of the ability to deal with numerous numbers of data. Artificial intelligence with the using of high technology can be a way to overcome these challenges. The aim of this research is to study the relationship between the capabilities of the artificial intelligent like analyzing data and predicting problems and give alternatives for solving these problems and all of these operations can be done with very high accuracy and in a very short time.

Problems like vehicles' accidents, routes` defects, maintenance periodical schedules, Traffic congestion, pollution, Traffic Violations … etc. are some of the problems that face the transportation field and that can be solved with better performance by using the applications of the artificial intelligence in this field.

This research will study the different applications of artificial intelligence in the transportation field and see how each application can solve the problems that can be considered as challenges in the way of achieving the sustainable development goals in this field.

2. Literature Review:

2.1 Sustainable Development and Transportation:

Sustainable development term was emerged at the start of 1970 and it was as a result of revolution of many ideas that try to make the world much better place for us and the future generations. It was emerged from the ideas of "sustainability", "Growth" and Development" [1] as they found that growth and development should be done but in a sustainable way as there will not be any effective growth or development if it compromise the future generations to meet their own needs.[2]. Sustainable development can simply be defined as guiding principles that focus on preserving the natural resources found on earth and the natural eco systems in line with the human development. [3]

Sustainable development goals are a number of goals that were adopted on September 2015 by all the United Nations Members, they set 17 goals to achieve, and 169 targets that include all the aspects of life and which [4] aim to the end of poverty and unemployment, and to make fields such as education and Health much more better.

Sustainable and smart urban transportation is one of the goals that are associated with the sustainable development goals especially the eleventh goal which stated "Sustainable Cities and Communities: make cities and Human Settlements inclusive, Safe, resilient and sustainable". [5] The focus on transportation at a global level has persisted in the past few years.[6] At the 2012 United Nations Conference on Sustainable Development (Rio +20), leaders from around the world acknowledged in unison that transportation and mobility play a crucial role in sustainable development. Sustainable transportation has the potential to boost economic growth and enhance accessibility. It also promotes better integration of the economy while upholding environmental conservation, improving social equity, health, resilience of cities, urban-rural connections, and productivity in rural areas.

Sustainable transport is integrated into various SDGs and targets in the 2030 Agenda for Sustainable Development particularly those concerning food security, health, energy, economic

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growth, infrastructure, and cities and human settlements. [7] The significance of transport for climate action is also acknowledged under the UNFCCC - the transport sector will have a particularly crucial role in fulfilling the Paris Agreement, as nearly a quarter of global greenhouse gas emissions related to energy are attributed to transport, and these emissions are expected to increase significantly in the future.

2.2 Sustainable Development Challenges in the Transportation Field:

Sustainable development in the transportation field can be achieved by providing comfort, safety, ease of handling, and high efficiency transportation system, taking into account the environmental aspect and eliminating harmful emissions that harm the environment. But it is not always easy to have a transportation system that fulfills all these conditions. Many challenges constrain achieving sustainable development goals in the transportation field which are:

Safety Issues` Challenges: The New Penguin English Dictionary defines safety as "the state of being protected from causing or experiencing harm or loss." [8] In the Transportation field feeling safe is really a challenge as there are many reasons that can make the transportation field "unsafe". According to "John J. Zogby, et al." there are four main categories of safety items in the transportation field [9] which are: Road Safety, Vehicle Safety, Human-Driver safety and Injury prevention & Control Plan.

Road Safety: Road fatalities and injuries represent a substantial worldwide issue. Traffic accidents represent a significant contributor to mortality, injury, and disability globally, affecting both developed and developing nations. It is estimated that every minute, two individuals lose their lives; while 95 others sustain severe injuries or face permanent disabilities as a result of road incidents worldwide. [10] The following table (Table 1) shows the factors affecting road safety.

Table 1: Factors Affecting Road Safety

Factor	Code	Explanation
Road Design	S.1	-The fundamentals of directing, designing, and assessing a roadway encompass the design aspects of horizontal projection, vertical projection, and cross-section.[11] -Within residential areas, safe roads are equipped with sidewalks, bike lanes, designated crossing points, and traffic calming measures. -Road Design must include the following elements: Road Elements, Intersections Design, and Design Controls.
Road and infrastructure Maintenance	S.2	Regular maintenance of roads with all their components, in addition to infrastructure maintenance, which includes drainage, supply, gas pipes, electricity and telephone cables.
Early detection of problems	S.3	Early detection of problems is the main key to solving them, as any problem, if left to worsen, obstructs the flow of the road and may cause many road accidents and collisions.
Smart Solutions for Problems	S.4	Smart solutions to problems are mainly characterized by intelligence, speed and accuracy. Therefore, the presence of such solutions greatly increases the rate of safety on the roads.

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Fig. 1. Road Safety affected by many Factors. Source: https://www.roadsafetyfacts.eu/uploads/2019/03/FAQs-02-1.svg (accessed July 2024)

Vehicle Safety: Regular safety checks of vehicles are essential for safeguarding for both drivers and other road users. By performing regular assessments and maintenance, it is east to detect possible concerns before they escalate into significant issues, thereby minimizing the likelihood of accidents and mechanical failures. The following table (Table 2) shows the factors affecting Vehicles safety.

Table2: Factors Affecting Vehicle Safety

Factor	Code	Explanation
Vehicles Design	S.5	The efficiency and safety of vehicles are influenced by their design, as well as by factors such as price and manufacturing date. Vehicles with poor design are at a higher risk of experiencing brake failure, steering problems, tire blowouts, and other issues that can lead to serious accidents.
Vehicles` Maintenance	S.6	Regular inspections and maintenance help in detecting possible problems early on, preventing them from escalating into serious issues and ultimately decreasing the likelihood of accidents and equipment failures.
Vehicles` Problems` detection	S.7	Despite the regular maintenance carried out on cars, sudden breakdowns may occur, and in this case the car driver may resort to a mechanic to begin repairs, and here two problems often occur: either failure to discover the cause behind the problem and thus not Fixing it, or discovering the problem, but fixing it is done wrongly and incorrectly... In both cases, the car and the driver are in an unsafe state.
Vehicle Technologies	S.8	Technologies like "blind Spot Detection", "Cross Traffic Alerts", "airbags", "Lane Departure Warning", "Automatic Emergency Break" are some of the types of technology that cars are equipped with to increase the safety factor while driving.

Driver/Pedestrian Safety: The examination of statistical road accident data indicates that the majority of incidents are attributed to driver error. [12] Therefore, the primary focus of motor psychology continues to be the investigation of human behavior in order to enhance road safety and minimize the occurrence of accidents.

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Another type of human errors that because accidents are pedestrian errors in terms of non-compliance with traffic lights at the intersections, as well as non-compliance with the places designated for crossing and places designated for pedestrian`s traffic. The following table (Table 3) shows the factors affecting Driver-Human safety.

Table3: Factors Affecting Driver/pedestrian Safety

Factor	Code	Explanation
Driver Behavior	S.9	The driver's behavior during driving includes following traffic laws, avoiding traffic violations, obeying traffic lanes, traffic signals, and signs.
Pedestrian Behavior	S.10	Regular inspections and maintenance help in detecting possible problems early on, preventing them from escalating into serious issues and ultimately decreasing the likelihood of accidents and equipment failures.

Control & Regulations for safety: Regulations refers to the set of rules and guidelines that govern the conduct and actions of individuals using the road. Its purpose is to minimize accidents and improve the smooth movement of traffic. [13] These laws are applied through traffic signs, traffic lights and all traffic related laws that regulate traffic. The more accurate and faster the process of identifying those who follow the instructions and those who do not follow them, the more this contributes to achieving sustainable development of the transport system. The following table (table 4) shows the main factors of the control and regulations.

Table 4: Factors of Control and Regulations

Factor	Code	Explanation
Traffic Signs	S.11	Traffic signs are signs installed on the side of or above roads in order to offer guidance or convey important information to drivers and they are divided into mandatory and Prohibitive signs.
Traffic lights	S.12	Traffic lights consist of a series of red, yellow, and green lights that regulate the flow of vehicles, typically at intersections or junctions of two or more roads.
Traffic Regulations	S.13	Traffic regulation encompasses the regulations and guidelines that dictate the conduct of road users. Its primary aim is to reduce accidents and improve traffic flow.

Fig 2: Examples of Traffic signs and Traffic Light, Source: https://c8.alamy.com (accessed August 2024)

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Efficiency Issues` Challenges: Transport efficiency is the measure of how well the transportation system in a city operates, taking into account technology, planning, and management to ensure that people can travel around the city easily and without delays. It is a crucial factor to consider when evaluating the smart mobility sector. [14] The following table (Table 5) shows the main factors that affect the efficiency of the transportation field.

Table 5: Factors Affecting the Efficiency of the transportation field

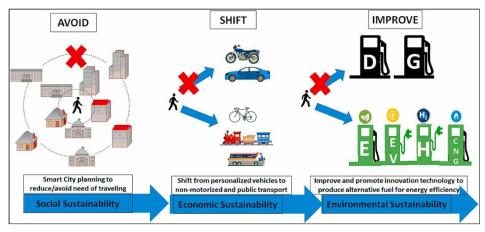| Factor	Code	Explanation
Efficient application of laws	E.1	Effective enforcement of laws means that laws are applied promptly, effectively and fairly among all individuals, leading to a reduction in the rate of legal violations and manipulation.
Efficient Data Analysis	E.2	Data analysis affects the vision of the current situation and the determination of future steps, so the process of collecting and analyzing data must be done accurately and quickly to keep pace with continuous changes
Prediction of future needs	E.3	Effective forecasting of future needs depends on the availability of data affecting the system and the quality of its analysis, as forecasting future needs is the first step to making all decisions for moving forward.
Use of smart systems	E.4	Relying on smart systems has become an indispensable necessity in the current era, where high accuracy, achievement, speed and low error rates.
Customer care	E.5	The user is the main element around which all other elements revolve and his service and comfort is the main goal of all improvement and development processes, so customer care is one of the most important means of determining the efficiency of the transport system
Monitoring and follow-up	E.6	Periodical actions to ensure that the progress processes are carried out correctly and in the right direction, and in light of the monitoring and follow-up processes, future plans are modified to keep pace with reality.
Continuous improvement	E.7	Continuous improvement is the next step after the monitoring and follow-up process, which leads to ensuring the efficiency of the system.
Efficient Management of Resources	E.8	Efficient management of resources, such as human resources, time, and technology. Equilibrium in task assignments, recognition of expertise deficiencies, and procurement of appropriate equipment all play a role in maximizing the use of resources.

Reliability Issues` Challenges: Reliability refers to the likelihood that a product, system, or service will effectively carry out its intended function for a set duration, or will function without any issues in a specific setting. [15] And in the transportation field one of the reliability issues is equity and the availability of the services in a good way for all people. The following table (Table 6) shows the most important factors that affect reliability in the transportation field.

Table 6: Factors Affecting the Reliability of the transportation field

Factor	Code	Explanation
Equality in the provision of services	R.1	Providing services to all equally and at a high level of quality
Data Security and Privacy	R.2	Data security safeguards information against unauthorized access, usage, and disclosure. Additionally, it defends against disruption, alteration, or destruction of that information.
Facilitate financial transactions	R.3	It is crucial to prioritize secure and convenient payment methods, particularly in public transportation, in order to minimize fraud.

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| Fraud detection | R.4 | Fraud detection involves a series of actions undertaken to prevent money or property from being obtained through false pretenses. Fraud detection methods should be used especially in the crowded public transportation. |

Environmental Issues` Challenges: The urbanization process is greatly impacted by the sustainability of transportation systems, which is evident through the increasing challenges of air pollution faced by major cities. Despite the limited control over population growth and migration patterns, the widespread reliance on public and private vehicles has significantly harmed our global environment. [16] This represents a very big challenge towards achieving sustainable development goals in the transportation field. Many Actions must be taken to deal with this Challenge as shown in figure 3.

Fig 3: Many Actions should be done to face The Environmental Challenges. Source: Shah, Kinjal, et al, " Green transportation for sustainability: Review of current barriers, strategies, and innovative technologies", Journal of Cleaner Production, Volume 326, (2021), 129392

The Following table (table 7) shows the main environmental challenges in the transportation field.

Table7: The main environmental challenges in the transportation field

Factor	Code	Explanation
Pollution Elimination	Env.1	The Transportation field can contribute significantly to reducing pollution rates if the field of transport takes a different turn in the energy sources it uses. The more reliance on clean energy sources in this field, the closer we are to achieving sustainable development goals.
Clean Energy Sources	Env.2	Usage of alternative fuels like Biodiesel, Electricity, Ethanol, Hydrogen, Natural Gas and Propane.
Treatment of Pollution Effects	Env.3	Air, Water, weather and the whole environment are affected by the pollution effects, so many studies, treatments; initiatives must be done to decrease the effect of pollution on our life.

2.3 The Artificial Intelligence:

Artificial intelligence is widely recognized as a potent technology that can greatly contribute to the advancement of environmental monitoring. This integration is becoming increasingly crucial across

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various sectors, as it plays a pivotal role in facilitating sound planning, disaster management, pollution control, and addressing environmental issues. [17]

AI Definition: Artificial intelligence as a technology is continuously expanding making it difficult to provide a comprehensive definition of it [18], AI functions by generating results according to a predetermined goal. This goal is translated from a human-defined objective into a mathematical one. The results can manifest as predictions, recommendations, or decisions.

Applications of AI: Artificial Intelligence plays a crucial role in modern society, offering solutions to intricate problems across various industries like Healthcare, entertainment, finance, education, and more. Its ability to streamline processes and enhance efficiency is making our daily lives more convenient and efficient. Figure 4 shows some of the different sectors that benefit from the Artificial Intelligence.

Fig 4: some of the different sectors that benefit from the Artificial Intelligence.Source: https://static.javatpoint.com/tutorial/ai/images/application-of-ai (Accessed: August 2024)

Applications of AI in the Transportation Field: Artificial intelligence in the field of transportation contributes in many applications that help in performing the functional tasks of the field better and to avoid accidents and traffic jams. The Following Table (table 8) shows the different Applications of AI in The Transportation Field.[19],[20], [21],[22]

Table8: The Different Applications of AI in the transportation field

Application	Code	Explanation
Traffic Flow Analysis	App.1	AI is set to address the problem of traffic congestion through the utilization of data gathered from sensors and cameras installed in high-traffic areas on roads. This data is transmitted to a cloud platform, examining traffic patterns. This enables important information about the current traffic situation, to make accurate predictions and enhance traffic flow efficiently.

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Automatic Traffic Incident Detection	App.2	By utilizing CCTV cameras and detectors strategically positioned across road networks, operators stationed at control centers are able to promptly react upon receiving notifications of any irregularities in traffic flow, such as accidents.
Finding empty parking places	App.3	The use of a range of IoT sensors and cameras allows for the collection of data to determine parking space availability, enabling drivers to be promptly notified and assisted in finding parking for their vehicles.
Detect Traffic Laws violations	App.4	The AI system is equipped to detect the real-time speed of passing vehicles on the road, and is capable of generating alerts for patrolling officers if any of the vehicles are found to be exceeding the speed limit.
License Plate Recognition	App.5	Automated License Plate Recognition (ALPR) uses computer vision technology to capture license plate information, location, and timestamp of potential violations through cameras placed on streets The data is then sent to a central server for processing.
Self-Driving Cars	App.6	Autonomous vehicles are one of the most exciting and highly anticipated applications of AI in transportation. These vehicles will use AI technology to independently navigate and plan routes, incorporating sensors such as LiDAR, RADAR, and cameras to analyze their environment and make intelligent choices.
Road Defects Detection	App.7	In the field of transportation, AI using computer vision can accurately detect road defects and assess nearby infrastructure by monitoring changes in asphalt & concrete surfaces.
Driver behavior Analytics	App.8	The incorporation of computer vision technology in car interiors will enhance driver monitoring by using facial recognition to predict changes in a person's emotions and analyzing the driver's body position to identify signs of tiredness.
Drone Taxis	App.9	Drone taxis are projected to greatly improve the speed at which people reach their destinations. These aerial vehicles are expected to be designed for either remote piloting or autonomous operation, allowing them to maneuver around obstacles and perform takeoffs, flights, and landings with impressive precision. Numerous delivery companies have already successfully incorporated drones into their delivery services.
Sustainable Transportation Solutions	App.10	AI can improve energy efficiency, promote eco-friendly driving behaviors, and facilitate the integration of electric and autonomous vehicles into transportation networks.
Reducing Carbon Emissions	App.11	AI-driven logistics and routing systems will give preference to eco-friendly choices, thereby decreasing carbon footprints and encouraging sustainable transportation.
Smart traffic lights	App.12	Intelligent traffic signals have the capability to modify their signal durations in real-time, depending on the prevailing traffic conditions, thereby enhancing the efficiency of traffic movement.
Advanced Safety Systems	App.13	Advanced object detection and recognition algorithms, along with collision avoidance systems powered by AI, are set to enhance the safety of both vehicles and pedestrians.
Predictive Maintenance	App.14	Artificial intelligence will aid in the detection of possible maintenance issues in vehicles and infrastructure, enabling preemptive maintenance and reducing the likelihood of accidents resulting from mechanical malfunctions.

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Traffic Management	App.15	By processing extensive real-time data from multiple sources such as sensors, GPS technology, and social media platforms, AI algorithms will deliver precise and current traffic forecasts. This capability will facilitate improved traffic management strategies
Personalized Experience	App.16	AI has the capability to customize in-vehicle infotainment systems according to the preferences and requirements of the driver.
Fewer Accidents	App.17	The application of artificial intelligence in transportation has the potential to minimize the likelihood of road accidents and improve safety by providing drivers with real-time information regarding traffic conditions and possible dangers.
Vehicle Tracking	App.18	AI-powered vehicle monitoring systems provide real-time insights into a vehicle's location, condition, and performance. By utilizing GPS data, sensors, and predictive analytics. This result in reduced fuel costs, improved delivery timelines, and ensures the overall efficiency of the transportation system.
Ticket validation and fraud detection	App.19	Fare evasion not only leads to decreased revenue for public transport authorities but also compromises the integrity of the system. Utilizing artificial intelligence algorithms can efficiently oversee fare collection, detect potential fraud, and address irregularities.
Automated Customer Services	App.20	AI-powered Chatbots and virtual assistants are employed in airports and train stations to provide real-time updates on travel schedules and possible delays.

The previous table stated twenty applications for the AI in the transportation Field and this number is expected to increase as the reliance on artificial intelligence increases in various tasks in the future.

3. Methodology:

To study the Relation between the Artificial Intelligence`s Applications and its impact on facing the sustainable development challenges in the transportation field, and after stating what are the most effective challenges that face the transportation field, and the main applications of the artificial intelligence in that field, a questionnaire was designed to investigate the opinions of experts and specialists about each application and whether it has a role in facing one or more of the stated twenty eight challenges. A total of 40 experts from the domains of transportation, planning, Environment and technology participated in the questionnaire, and based on their responses, the subsequent matrix (table10) was developed. The Matrix shows the relation between the AI applications and the sustainable development challenges to see if the AI application can be a tool for facing these challenges.

The sample of the questionnaire is categorized as follows: 16 experts in the Transportation sector, 8 in the Planning sector, 7 in the Environmental sector, and 9 in the Technology sector.

Analyzing the questionnaire results depends on the number of responds on each challenge within each application, as the questionnaire is designed of 20 questions, each question ask about one application of the AI applications stated in the Research, and the choices are the 28 challenges with a checkbox in front of each one and they are repeated the same in all the 20 questions. Each expert checks the challenges that they see in their opinion that the application can deal with.

Counting the number of responds on each Challenge through the 50 responds and through the 20 questions we can get three types of relations (table 9):

Table9: The three degrees of relations according to the results of the questionnaire

Relation	Symbol	Percentage of responds
Strong	●	50-100%

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Weak	-	20-49%
Never	×	0-19%

- The strong relation: means that the AI application strongly deals with the challenge and most of the experts assured that there is a direct relation between them.

- The Weak Relation: means that the AI application don't affect directly the challenge, it may deals with it with one way or other but not directly.

- Never: means that there is no relation between the AI application and the challenge.

Through these relations we can have an idea about the most probable AI application that can be used to face a certain sustainable development challenge in the transportation field and to what extend using AI in the transportation field can be used as a tool for facing these challenges.

4. Results:

The Following Matrix (table 10) which depends on the responds of experts on the questionnaire show the relation between each AI application in the transportation field and the 28 challenges that face the field to know what are the most important applications that must have priority to be applied in the transportation field to be a tool for facing Sustainable Development Challenges in the Transportation Field.

Table10: The relation between the AI applications and the sustainable development challenges

	Code	App.1	App.2	App.3	App.4	App.5	App.6	App.7	App.8	App.9	App.10	App.11	App.12	App.13	App.14	App.15	App.16	App.17	App.18	App.19	App.20
Safety Issues Challenges	S1	-	●	●	●	×	●	●	×	●	●	×	●	●	×	●	×	●	-	×	×
	S2	●	●	×	●	×	●	●	×	×	-	×	×	●	●	×	×	●	×	×	×
	S3	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	S4	●	●	●	●	-	●	●	●	●	●	●	●	●	●	●	-	●	●	●	●
	S5	×	×	×	×	×	●	-	●	●	●	●	×	●	●	×	●	●	●	×	-
	S6	×	×	×	×	×	●	×	×	×	×	×	×	●	●	×	×	●	×	×	-
	S7	×	●	×	×	-	●	-	●	×	×	×	×	●	●	×	×	●	●	×	×
	S8	×	×	●	×	×	●	●	●	●	●	●	×	●	●	×	●	●	●	×	●
	S9	-	×	-	●	-	●	×	●	×	×	×	×	●	×	-	●	●	●	×	×
	S10	×	×	×	●	×	●	×	×	×	-	×	-	●	×	×	×	●	×	●	×
	S11	●	×	●	×	×	-	×	×	×	-	×	●	●	×	●	×	●	×	×	×
	S12	●	×	×	×	●	-	×	×	×	-	×	●	●	×	●	×	●	×	×	×
	S13	●	-	×	●	●	-	×	●	-	●	●	●	●	×	●	×	●	×	×	×
Efficiency Issues	E1	-	●	×	●	-	-	×	×	×	×	×	×	●	×	●	×	●	×	●	●
	E2	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E3	●	-	●	-	-	-	●	●	-	●	-	●	●	●	●	●	●	-	×	●
	E4	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

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	Code																				
	E5	×	-	●	×	-	●	●	●	●	●	×	-	●	●	-	●	-	-	×	●
	E6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E7	●	●	●	●	-	●	●	●	-	●	●	●	●	●	●	●	●	●	●	●
	E8	●	●	●	●	×	●	●	●	●	●	●	●	●	●	●	●	-	●	●	●	-
Reliability Issues Challenges	R1	●	×	●	●	×	-	●	-	-	●	●	●	●	●	●	●	●	●	●	●
	R2	●	●	●	●	×	●	●	●	×	×	×	×	●	-	●	●	●	●	●	●
	R3	×	×	×	-	×	●	●	×	●	●	×	×	×	×	●	×	×	●	●	●
	R4	×	×	×	●	●	×	×	●	-	●	×	×	●	×	×	×	×	×	●	×
Environmental Issues Challenges	Env 1	●	●	●	●	×	●	×	×	●	●	●	×	×	×	×	×	●	●	×	×
	Env 2	×	×	×	×	×	●	×	×	●	●	●	●	×	×	×	×	×	×	×	×
	Env 3	●	-	-	-	×	●	●	×	●	●	●	●	●	●	-	×	●	●	×	×

According to the previous matrix we can analyze the following Results:

- All of the AI applications contribute in facing one or more of the sustainable development challenges in the Transportation Field

- AI has some of the characteristics that help in making it an efficient way to face the challenges of the transportation field which are (Accuracy – Low error rate – high capabilities of data analysis – high capabilities of problems detection – Giving accurate Reports – problems detection – Monitoring – high update rate)

- AI Contribute in solving most of the challenges that face the transportation field whether its contribution is high or low, but the following Challenges are the most challenges that are highly affected by using AI:

The Safety Challenges: the next table (table 11) shows the most highly affected safety challenges by the AI applications through counting the number of applications that have strong relation with the challenge and take the highly.

Table11: The most positively affected safety challenges by the AI applications

Code	Challenge name	no. of Apps	Comment
S3	Early detection of problems	20	AI apps. Using collected data to early detect problems and prevent their consequences which increase safety.
S4	Smart solutions for problems	18	The next step after detection is proposing smart solutions for these problems which increase safety in the transportation system.
S8	Vehicle Technologies	13	Cars that depend on technology in many aspects have more safety ratio than cars without technologies.

The Efficiency Challenges: the next table (table 12) shows the most highly affected Efficiency challenges by the AI applications through counting the number of applications that have strong relation.

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Table12: The most positively affected Efficiency challenges by the AI applications

Code	Challenge name	no. of Apps	Comment
E2	Efficient data analysis	20	It can be considered the most important feature of AI.
E4	Use of smart systems	20	High Accuracy – Low Error Rate
E6	Monitoring and follow up	20	The next step after analyzing data.
E7	Continuous improvement	18	Efficiency of the system increase by the continuous improvement.
E8	Efficient Management of resources	17	No resource waste through smart usage.

The Reliability Challenges: the next table (table 13) shows the most highly affected Reliability challenges by the AI applications through counting the number of applications that have strong relation.

Table 13: The most positively affected Reliability challenges by the AI applications

Code	Challenge name	no. of Apps	Comment
R1	Equality in the provision of services	15	Equality can easily be achieved by AI apps.because it has no emotional aspects.
R2	Data Security and Privacy	14	Saving data means reliable system and that is a high advantage of using AI.

The Environmental Challenges: the next table (table 14) shows the most highly affected Environmental challenges by the AI applications through counting the number of applications that have strong relation.

Table 14: The most positively affected Environmental challenges by the AI applications

Code	Challenge name	no. of Apps	Comment
Env1	Pollution Elimination	10	Through depending on smart and clean systems and resources.
Env2	Treatment of Pollution Effects	11	Collecting data, propose solutions then implementation of smart clean systems.

5. Conclusion:

- Artificial intelligence can be a tool for facing the sustainable development challenges and its capabilities are growing with time through the continuous improvement and learning from each experience to be always on the right path.\

- AI applications can make a very big difference in the transportation field and improve the safety issues which save much more lives and decreasing the death rate that happens through collision accidents.

- The Efficiency of AI applications in Analyzing collected data in a very accurate, comprehensive and efficient way makes it a reliable solution for increasing sustainability and achieving the sustainable development goals.

- The Integration between all the available smart systems to get the benefits of the capabilities of these systems.

- Future studies can be done according to this research about how to increase the relation between AI applications in the Transportation field and all the sustainable development challenges.

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